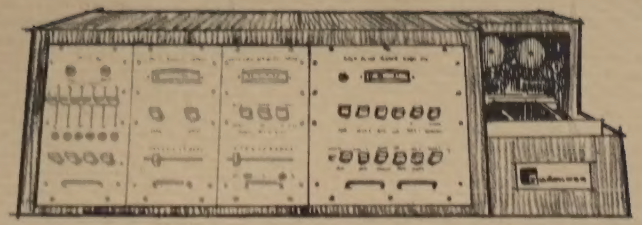

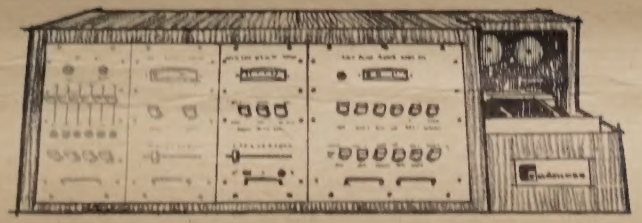

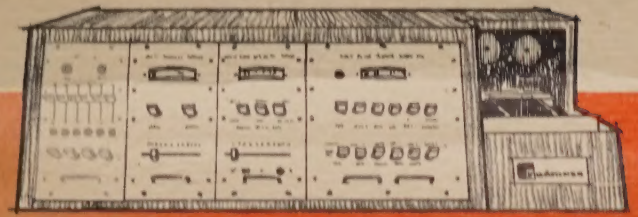

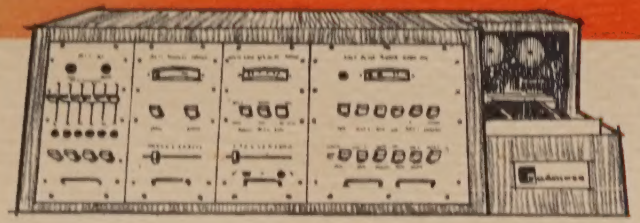

RUDMOSE® MODEL ARJ-5
DIAGNOSTIC BÉKÉSY AUDIOMETER

CLINICAL MANUAL

TRACOR™ Medical Instruments Division
6500 Tracor Lane, Austin, Texas 78721, AC 512/926-2800

MM-102

CLINICAL MANUAL

RUDMOSE® MODEL ARJ·5 DIAGNOSTIC BÉKÉSY AUDIOMETER

11957

May 1968

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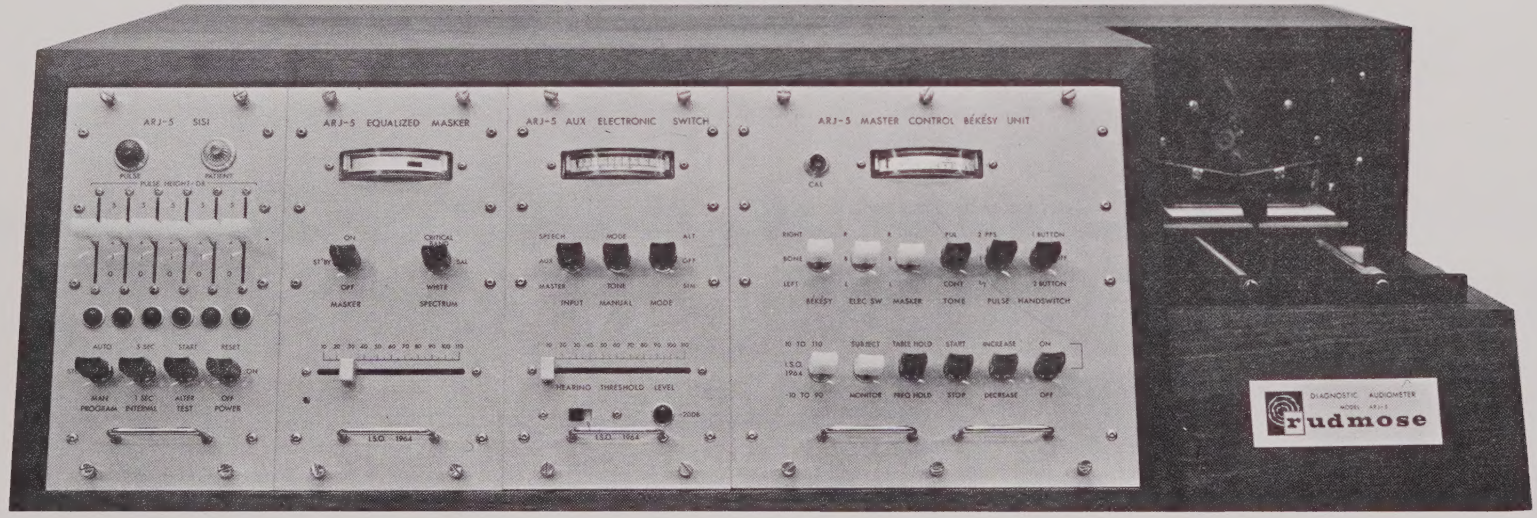

RUDMOSE® ARJ-5 DIAGNOSTIC AUDIOMETER, FRONT VIEW

PREFACE

This first edition of the Clinical Manual for the Rudmose® ARJ-5 Diagnostic Békésy Audiometer is intended to serve as a guide to the student, and as a refresher for the practicing audiologist. It is not designed as a comprehensive textbook, but as an operation manual for specific techniques.

Many variations of tests exist, and the methods presented here are intended to stimulate thought and discussion by the student. For complete discussion and interpretation of techniques presented here, the reader should rely upon the references provided and upon his own sources.

The format of this manual is a departure from that of previous TRACOR Manuals and requires some explanation. The sections on clinical operation are independent units which may be replaced or added as revisions occur or new tests are designed. Additions to this manual may be easily accomplished. The first page of each section serves as a title page and states the purpose or conditions for use of that test. The second page contains a picture of the ARJ-5 control panel, with control panel settings indicated for the particular test. On the third page are instructions for setting the controls, and references to the literature for that technique, followed by the clinical procedure and interpretation.

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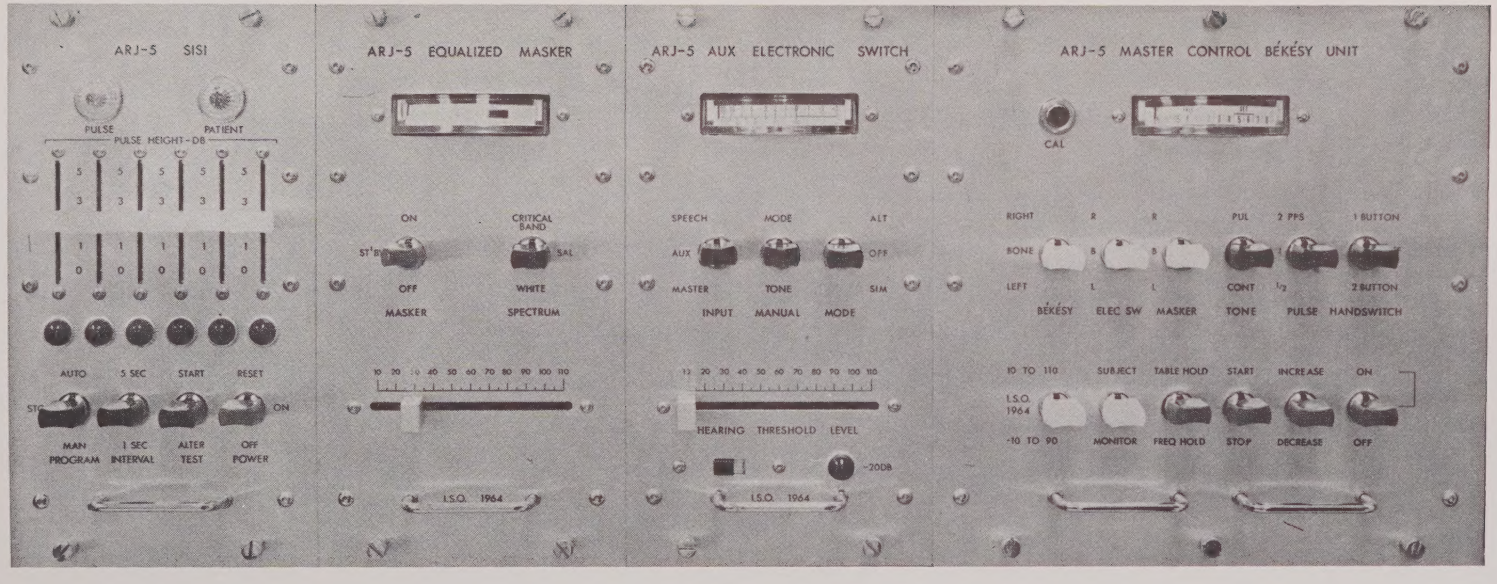
ARJ-5 CONTROL DESIGNATION

Section 1



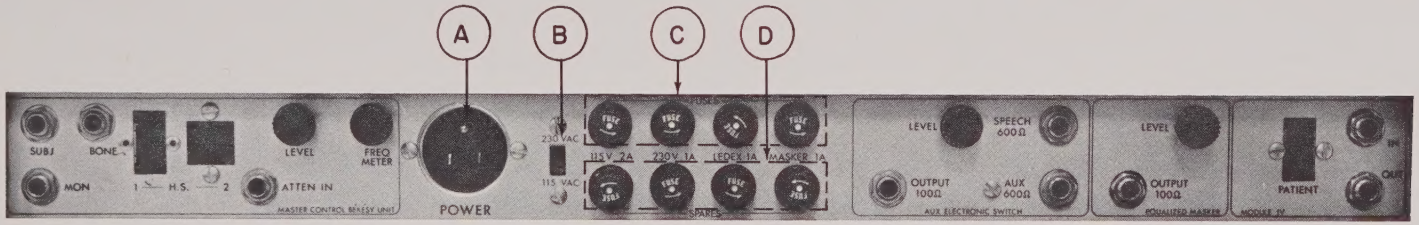


Figure 1A. Total Unit Controls

1. ARJ-5 TOTAL UNIT (Rear Panel)

A.	POWER	This socket is the power input point for the total ARJ-5 instrument and may be supplied with either 115 VAC or 230 VAC at 50-60 Hz.
B.	230 VAC/115 VAC	This slide switch, located immediately to the right of the POWER socket, must be in the position corresponding to the input line voltage.
C.	FUSES	These are the fuse holders (115V 2A, 230V 1A, Ledex 1A, Masker 1A) for the active protective fuses.
D.	SPARES	These holders contain spare fuses for the active protective fuses located directly above them.

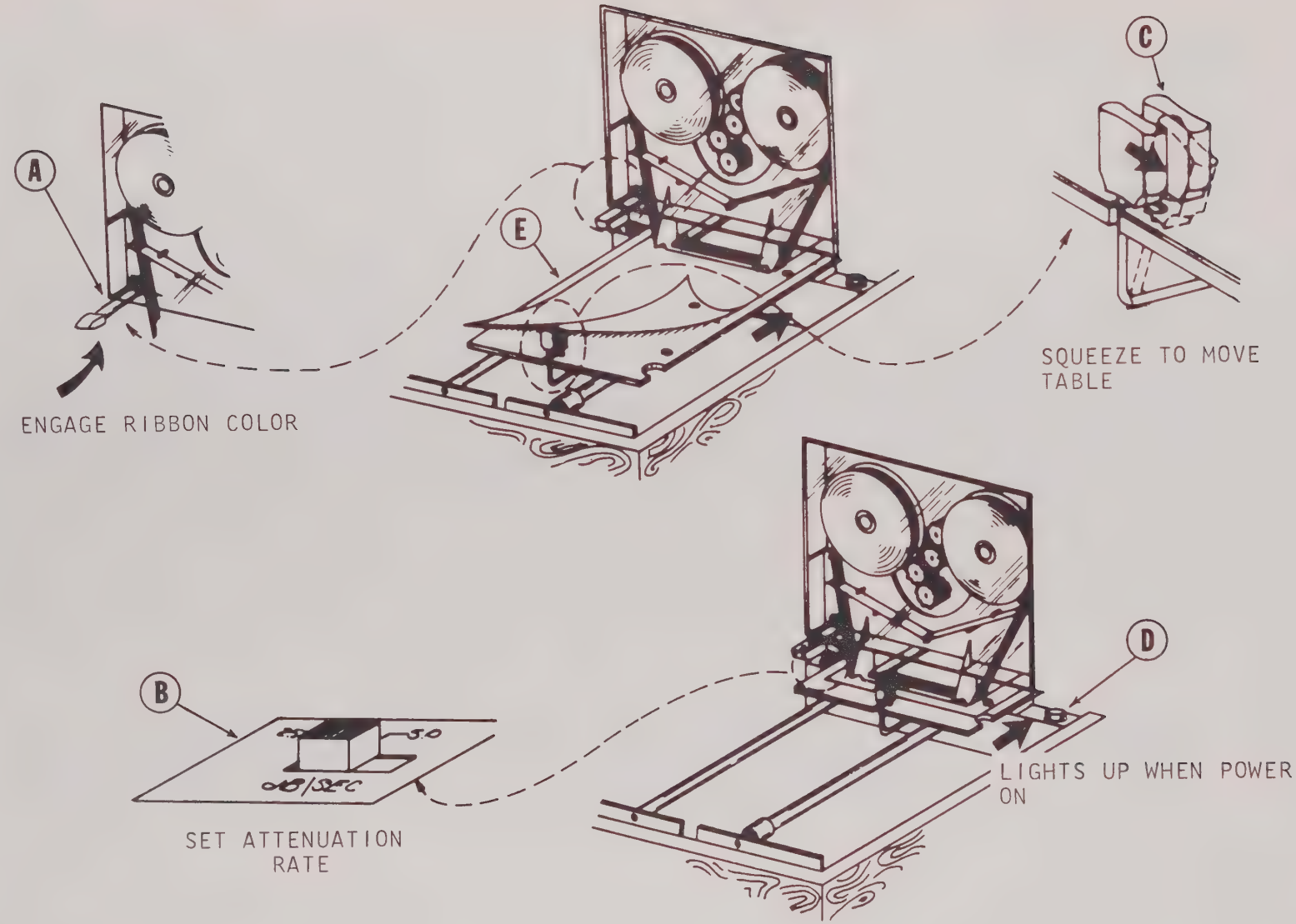


Figure 1B. ARJ-5 Recording Unit

B6-106-114

2. ARJ-5 RECORDING UNIT

A.	Ribbon Color Lever	This lever, located at the lower left of the ribbon mechanism, changes the half of the ribbon upon which the stylus presses.
B.	2.5 dB/SEC 5.0 dB/SEC	This slide switch, located to the left of the audiogram table, permits selection of an automatic attenuation rate of either 2.5 dB/sec. or 5.0 dB/sec. (Marginal notation may be made on audiogram card for retest consistency.)
C.	Table Release Knob	This knob, located on the front of the audiogram table, releases the table gears so that the table may be positioned for specific frequencies.
D.	Power Light	This light, located to the lower right of the audiogram table, indicates when the master power is on.
E.	Table	The table is itself a control since its position determines the frequency of the signal produced.

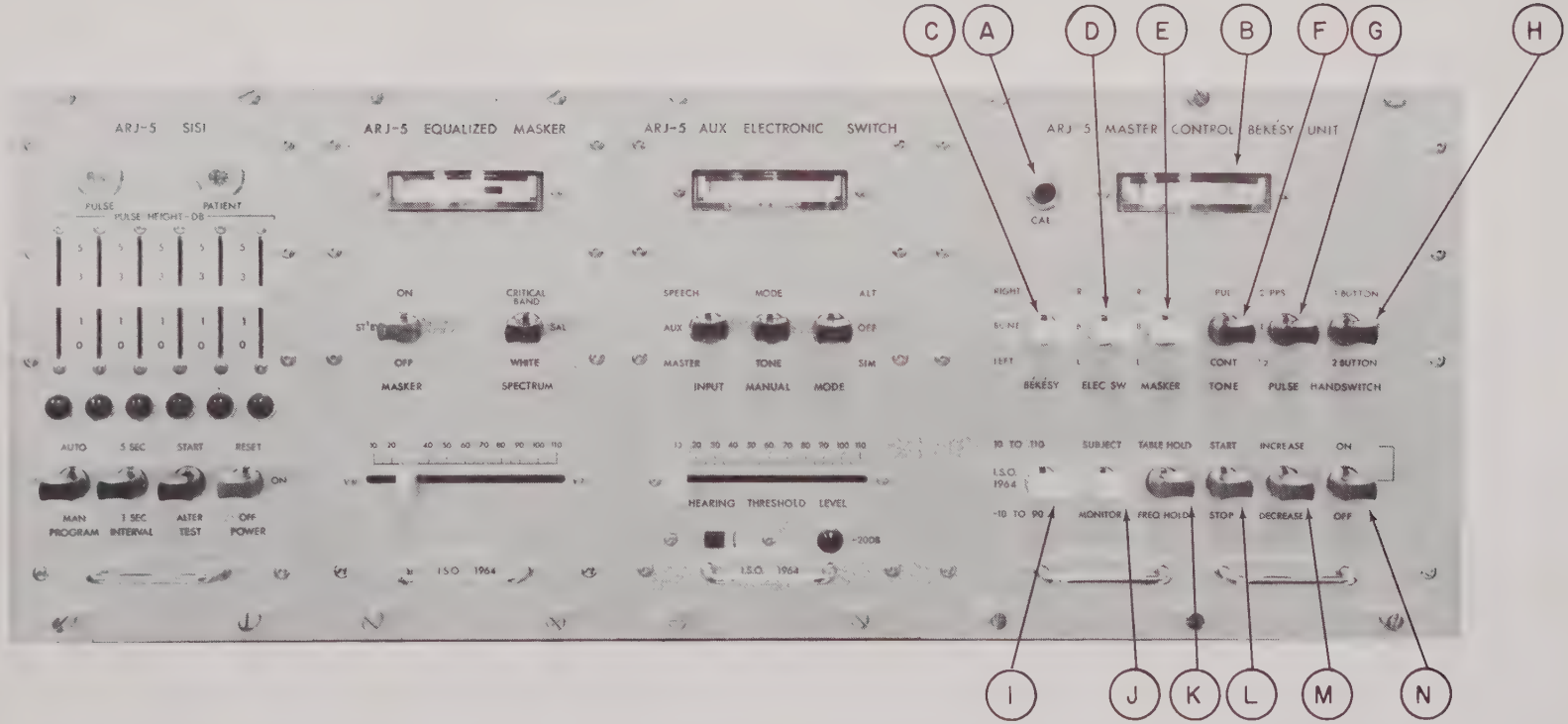


Figure 1C. MASTER CONTROL BÉKÉSY UNIT Controls

B6-106-132 B

3. ARJ-5 MASTER CONTROL BÉKÉSY UNIT

A. CAL

The CAL button is used in conjunction with the Master Control Békésy meter and the Master Control Békésy LEVEL control on the rear panel to calibrate the master unit output.

B. Master Control Békésy Meter

This meter, located at the top center of the Master Control Békésy panel, indicates the frequency being produced by the oscillator when the CAL button is not depressed, and indicates electrical output while the CAL button is depressed.

C. BÉKÉSY

This output switch routes the Master Control Békésy signal (frequency determined by the audiogram table position) to either the RIGHT or LEFT earphone or to the BONE conduction vibrator.

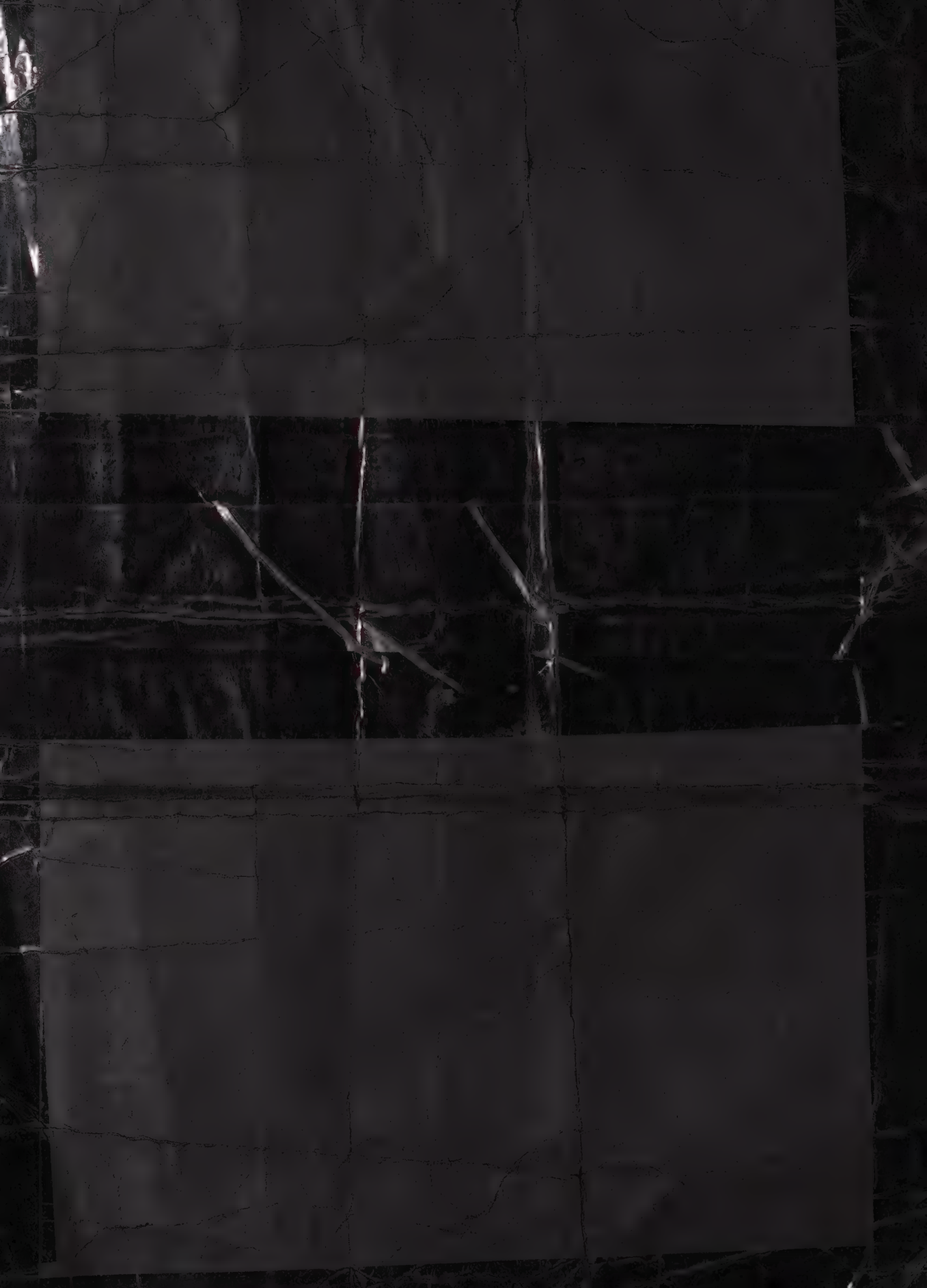
D. ELECTRONIC SWITCH

This output switch routes the signal when the Auxiliary Electronic Switch is to be used.

R position routes signal to right earphone
B position routes signal to bone conduction vibrator
L position routes signal to left earphone

E. MASKER

Three position switch routes the signal when the Equalized Masker module is to be used.



R position routes signal to right earphone
B position routes signal to bone conduction vibrator
L position routes signal to left earphone

F. TONE — Three position switch selects either a pulsed (PUL) or a continuous (CONT) tone. No signal is presented while the TONE switch is in the center position.

G. PULSE — This switch (operative only when the TONE switch is in the PUL position) permits selection of a pulse rate of ½, 1 or 2 pulses per second. (Marginal notation may be made on audiogram card for test-retest consistency.)

H. HANDSWITCH — This switch selects either the 1 BUTTON or 2 BUTTON handswitch, or in the OFF position converts to manual control by INCREASE/DECREASE switch.

I. Range Switch
10 TO 110
I.S.O. 1964
-10 TO 90 — This, the lower left switch on the Master Control Békésy panel, selects the decibel range available, i.e., either 10 to 110 dB (I.S.O.-1964) or -10 to 90 dB (I.S.O.-1964). No signal is presented while this switch is in the center position.

J. SUBJECT/MONITOR — This switch routes the output signals to either the subject's or the operator's earphones. No signal is presented while this switch is in the center position.

K. TABLE HOLD/ FREQ HOLD — This switch allows the audiogram table and frequency presentation to proceed in the programmed sequence (center position), the table and frequency to be held in a stationary synchronization (TABLE HOLD), or the table to move while the frequency remains the same as that at which the switch was activated (FREQ HOLD).

L. START/STOP — This switch begins and interrupts an automatic test. When the switch is placed in the START position (the START position is spring loaded and will return the switch to the center position), the test begins and will continue until completed or interrupted by placing the switch to the STOP position.

M. INCREASE/ DECREASE — This switch permits manual attenuation of the signal being presented. The switch is spring loaded toward the center, and the signal intensity changes only while the switch is held either to DECREASE or INCREASE the signal. This switch will override the HANDSWITCH in all positions.

N.	ON/OFF	This is the master power switch for the ARJ-5 instrument. Either the center or up positions are ON positions and the down position is OFF.
O.	SUBJ (Rear Panel)	This jack provides the output to the subject's earphones.
P.	BONE (Rear Panel)	This jack is the output to the bone conduction vibrator.
Q.	Handswitches -1 and 2 (Rear Panel)	These sockets are the connections for the single button and two button handswitches, respectively.
R.	LEVEL (Rear Panel)	This control, in conjunction with the CAL button and the Master Control Békésy meter, calibrates the output level.
S.	FREQ METER (Rear Panel)	This control calibrates the Master Control Békésy meter to read directly the frequency being presented.
T.	MONITOR (Rear Panel)	This jack is the output to the operator's (monitor's) earphones.
U.	ATTENUATOR INPUT (Rear Panel)	This jack permits the input of an external signal to the Master Control Békésy attenuator.

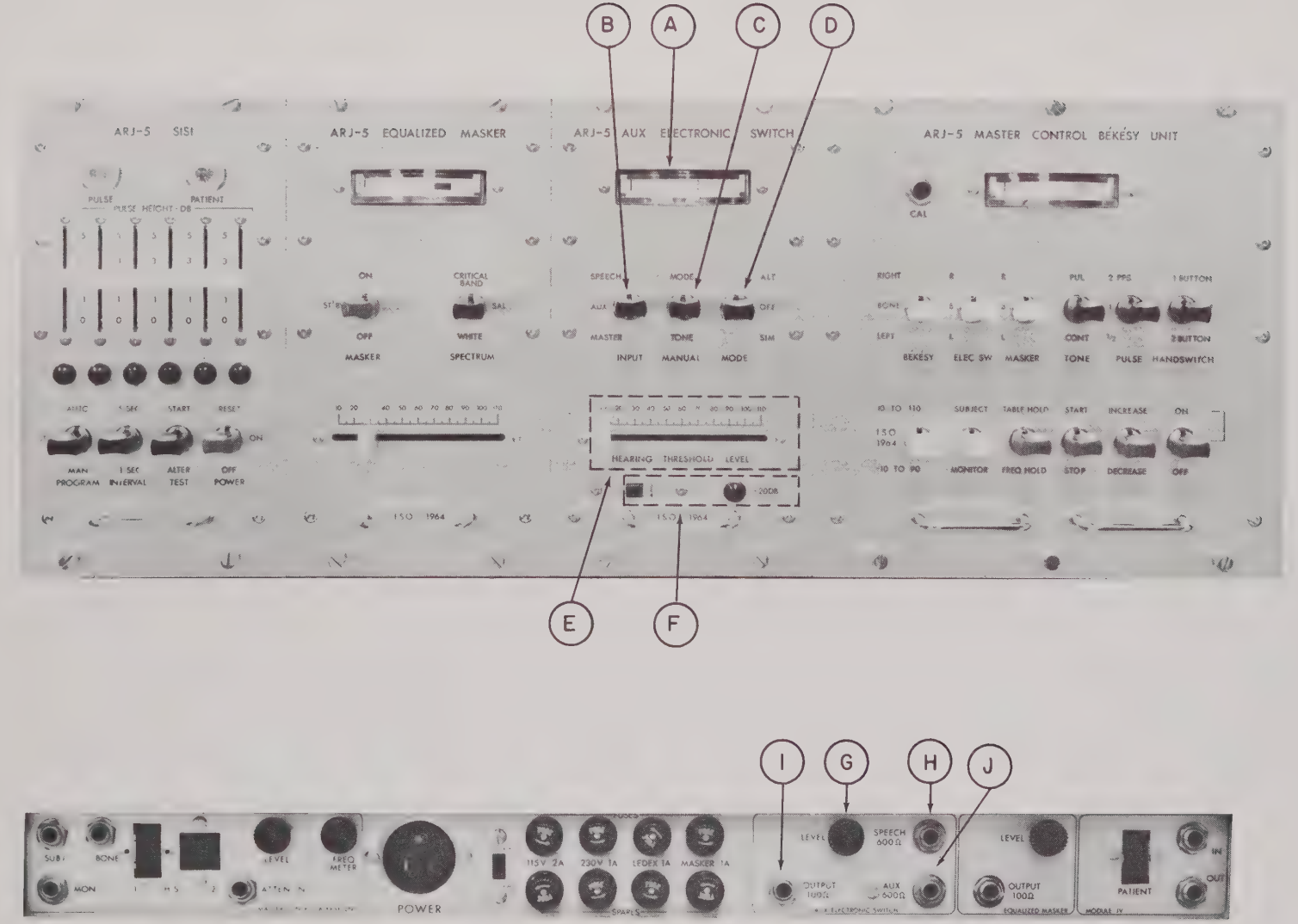
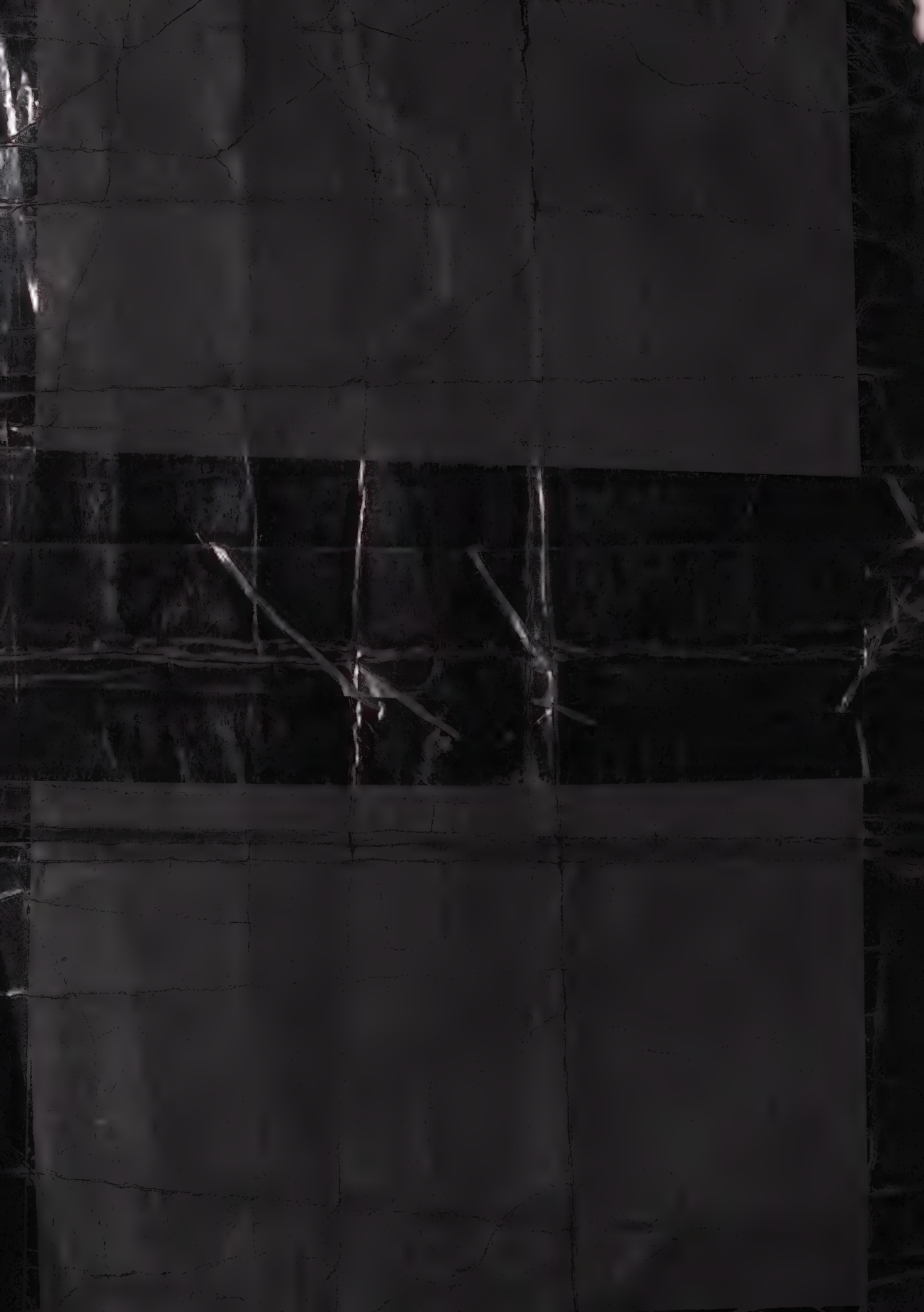


Figure 1D. AUX ELECTRONIC SWITCH Controls

B6-106-132 C

4. ARJ-5 AUX ELECTRONIC SWITCH

A.	Auxiliary Electronic Switch Meter	This meter, located at the top center of the Auxiliary Electronic Switch module panel, indicates the electrical output of the Auxiliary Electronic Switch attenuator.
B.	INPUT	This switch selects an input into the Auxiliary Electronic Switch attenuator from an external speech device (SPEECH), an external oscillator signal (AUX), or directly from the master oscillator of the Master Control Békésy unit (MASTER).
C.	MANUAL	This switch controls the mode of presentation of the signal. The MODE position provides a continuous signal. The TONE position is spring loaded and provides a signal only while held down (the tone is presented to the output selected by the ELEC SW switch on the Master Control Békésy panel). There is no tone presentation while the MANUAL switch is in the center position.
D.	MODE	This switch (when the Auxiliary Electronic Switch MANUAL switch is in the MODE position) selects presentation of the signal either alternately to each ear (ALT) or simultaneously to both ears (SIM). When this switch is in the OFF position, The ELEC SW switch on the Master Control Békésy panel controls the output selection.



E.	HEARING THRESHOLD LEVEL	This linear attenuator controls the output level of all signals presented through the Auxiliary Electronic Switch. The attenuator reads directly in decibels (except for 250 Hz, 7000 Hz, and 8000 Hz which are always in the range -10 to 90 dB) when the -20 dB switch is in the left-hand position. The maximum calibrated speech intensity is 90 dB.
F.	-20 DB Switch and Light	This slide switch, located at the lower left of the Auxiliary Electronic Switch panel, selects either a 10 to 110 dB range for the Auxiliary Electronic Switch attenuator (thus making it direct reading except at 250, 7000 and 8000 Hz) when in the left-hand position, or a -10 to 90 dB range when in the right-hand position (subtract 20 from the attenuator reading; at 250, 7000 and 8000 Hz, subtract 40 from the attenuator reading). The light is actuated when the -20 DB switch is in the right hand (-10 to 90 dB) position.
G.	LEVEL (Rear Panel)	This control, in conjunction with the Auxiliary Electronic Switch meter, permits calibration of the Auxiliary Electronic Switch module's electrical output.
H.	SPEECH 600Ω (Rear Panel)	This jack is the input point for a speech accessory unit, i.e., a microphone, tape deck or turntable.
I.	OUTPUT 100Ω (Rear Panel)	This output jack may be used for earphones or for a patch cable to another module.
J.	AUX 600Ω (Rear Panel)	This input jack provides for an auxiliary signal input.

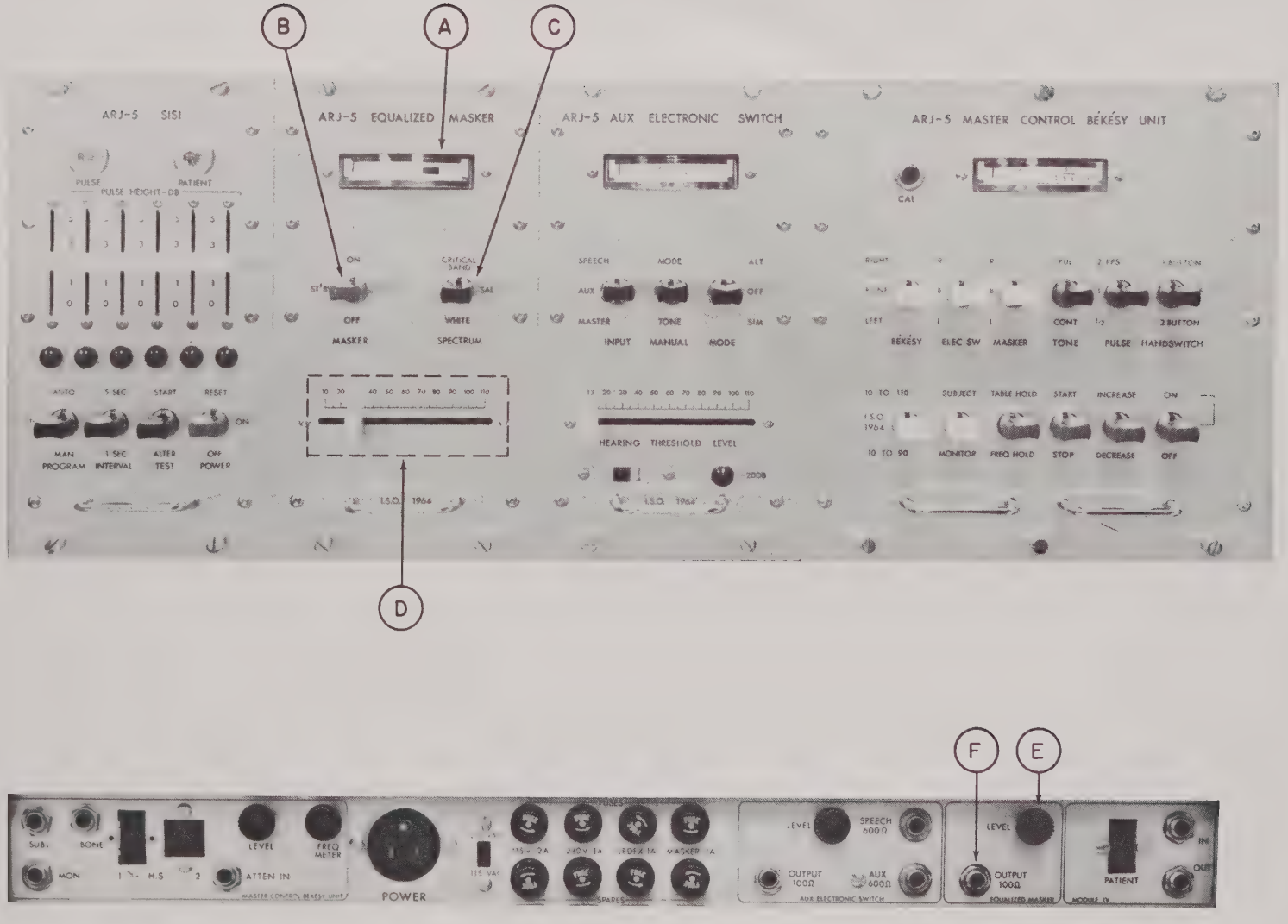


Figure 1E. EQUALIZED MASKER Controls

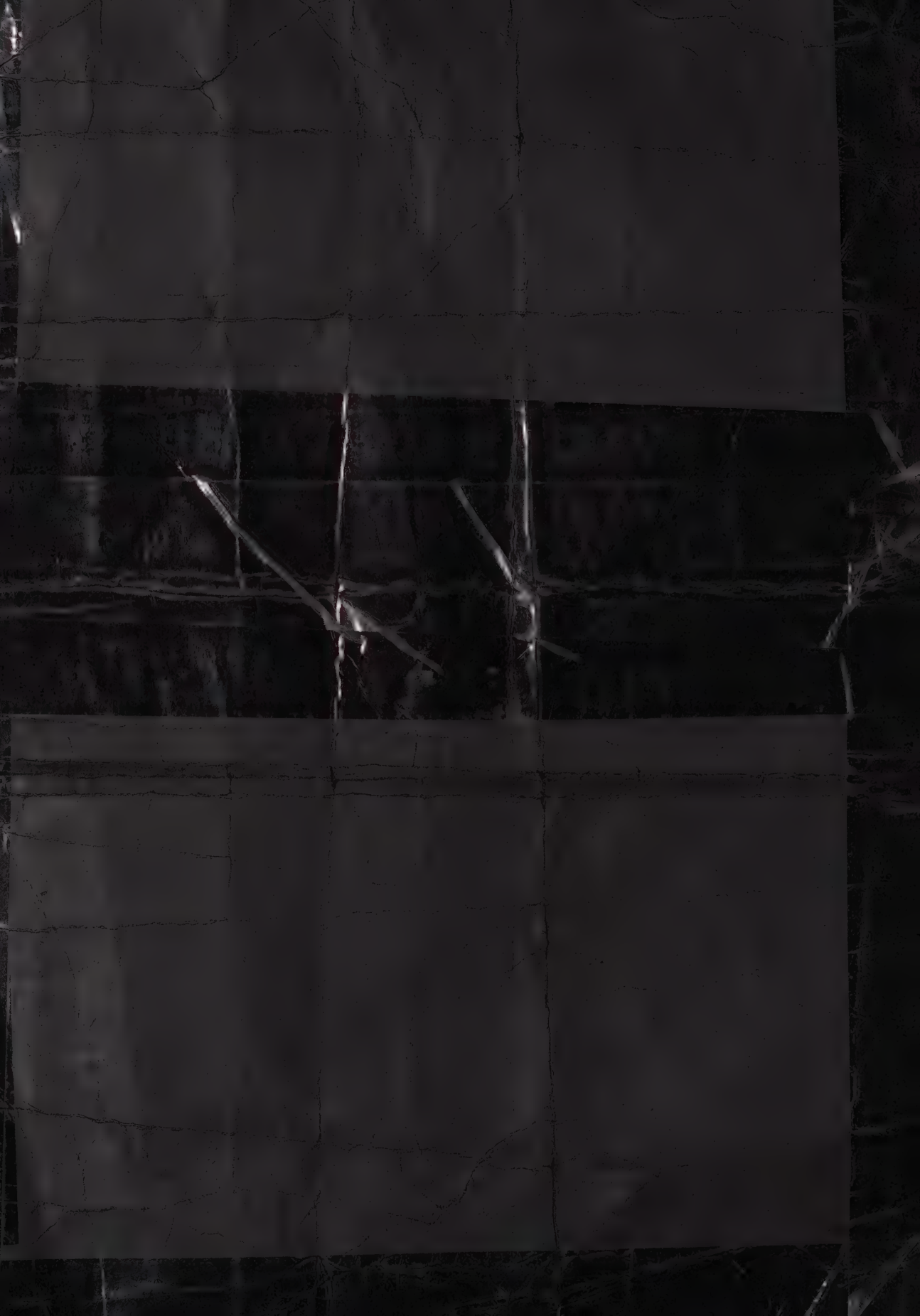
B6-106-127 A

5. ARJ-5 EQUALIZED MASKER

A. Equalized Masker Meter — This meter, located at the top center of the Equalized Masker panel, monitors the electrical output of the Equalized Masker module.

B. MASKER — This is the power switch for the Equalized Masker module. The OFF position removes all power from the module and the ON position always produces some level of noise since, for technical reasons, the attenuator has no zero position. The ST'BY (standby) position provides power to the tube filaments, but not to the remainder of the circuit. This position keeps the Equalized Masker module operationally available without the usual warm-up time.

C. SPECTRUM — This switch selects the type of masking noise. CRITICAL BAND noise is the most efficient bandwidth for masking because it requires the least amount of noise energy, is most comfortable to the subject, and the level of masking is calibrated in terms of HTL settings. As the frequency changes, the bandwidth and noise level change to assure uniform HTL Masking. Thus, if the attenuator is set on 60 dB and both noise and pure tone are delivered to the same ear, a person with normal hearing will show a masked threshold of 60 dB (±5 dB) for all frequencies. SAL noise



		has a uniform electrical energy per cycle range of 150 Hz to 5000 Hz. WHITE noise has a uniform electrical energy per cycle range of 150 Hz to 15,000 Hz. When earphones are used, the acoustical output energy is approximately uniform per cycle over the frequency range of 150 Hz to 6000 Hz.
D.	Equalized Masker Attenuator	This linear attenuator at the bottom of the Equalized Masker panel controls the intensity level of the noise output of the Equalized Masker module.
E.	LEVEL (Rear Panel)	This control calibrates the electrical output level of the Equalized Masker module.
F.	OUTPUT 100Ω (Rear Panel)	This output jack may be used for earphones or for a patch cable to other modules.

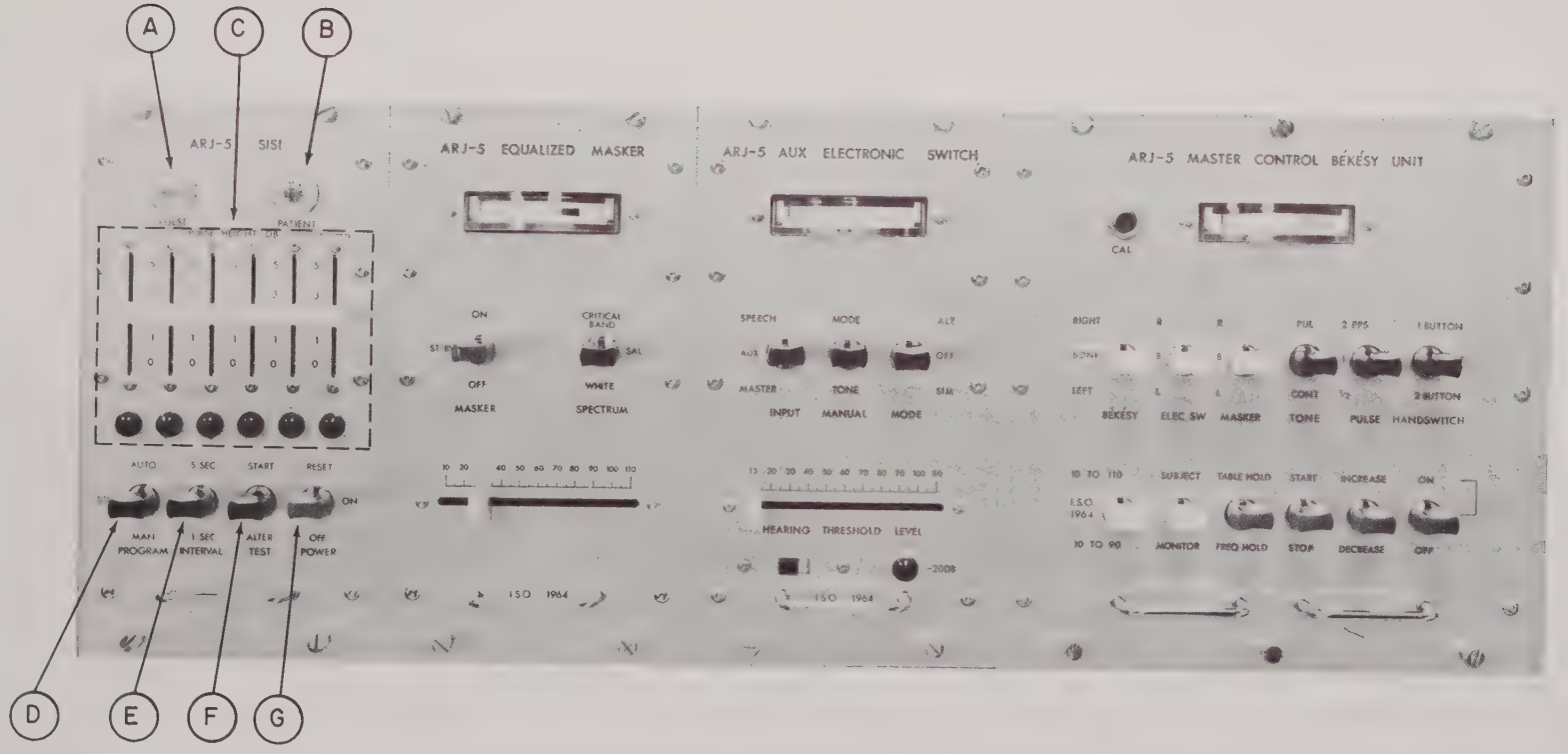
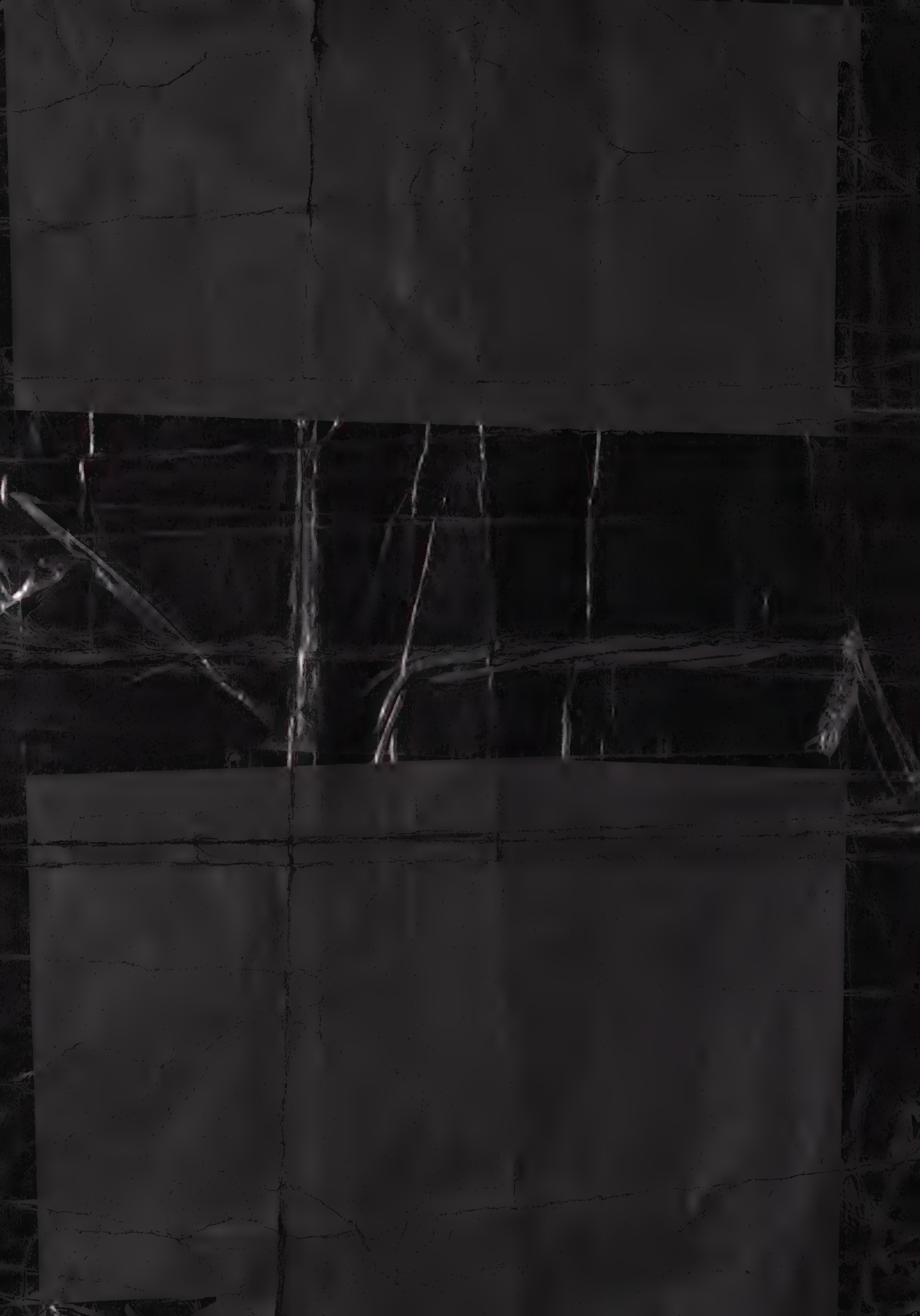


Figure 1F. SISI Controls

B6-106-127 B

6. ARJ-5 SISI

A. PULSE	This indicating light flashes with and only with the actual occurrence of a pulse.
B. PATIENT	The patient response indicating light flashes when the subject depresses the handswitch button to indicate a response.
C. PULSE HEIGHT-DB	These six switches control the pulse height of each of six sequential pulses presented by the SISI module. The respective pulse indicating lights below the switches indicate which of the six pulses is programmed next.
D. PROGRAM	This switch selects the mode of presentation of the SISI test. In the AUTOMATIC position, the SISI module cycles four times through the six pulses programmed on the PULSE HEIGHT switches for a total of 24 pulses and then stops. The switch is spring loaded in the MANUAL position and only one pulse is presented each time the switch is depressed. The STOP position may be used to completely stop an automatic test.



E.	INTERVAL	This switch selects the basic time interval between pulses (1, 3 or 5 seconds), and in conjunction with the 0 dB position on the pulse switches, may be used to program a variety of pulse patterns.
F.	TEST	This switch begins or interrupts the automatic presentation of a SISI test. The spring loaded START position begins the four cycle presentation of pulses. If at any time the switch is depressed to the ALTER position, the pulses continue but can be controlled from the single PULSE HEIGHT switch having an activated red indicating light.
G.	POWER	This switch controls the power input to the SISI module. The RESET position automatically returns the program to the first pulse. The center position is the ON position and the down position is OFF.
H.	PATIENT (Rear Panel)	This is the socket for the SISI unit handswitch. Use the one button handswitch.
I.	IN (Rear Panel)	This jack permits access for an external signal input.
J.	OUT (Rear Panel)	This jack provides access for output of the SISI signal.

CONTROLS - ACCESSORY EQUIPMENT

Section 2

Figure 2A. Accessory Equipment

B6-106-134

1. ACCESSORIES

A. Earphones

There are two sets of earphones for the ARJ-5. One set for the subject and one set for the monitor. The red earphone goes over the right ear and the blue earphone goes over the left ear.

B. Bone Vibrator

One Radioear Model B70A Bone Receiver (bone vibrator) is included with the ARJ-5.

C. One-Button Handswitch

Two one-button handswitches are in the ARJ-5 package. One is used for automatic recording tests and the other for response signaling in the SISI test. When used on the Master Control Békésy unit, the signal intensity increases while the button is up and decreases when it is depressed.

D. Two-Button Handswitch

One two-button handswitch is included in the ARJ-5 package. It is a convenient device for intensity balancing tests. The sound intensity decreases while the SOFTER button is depressed, increases while the LOUDER button is depressed, and remains constant while neither button is depressed.

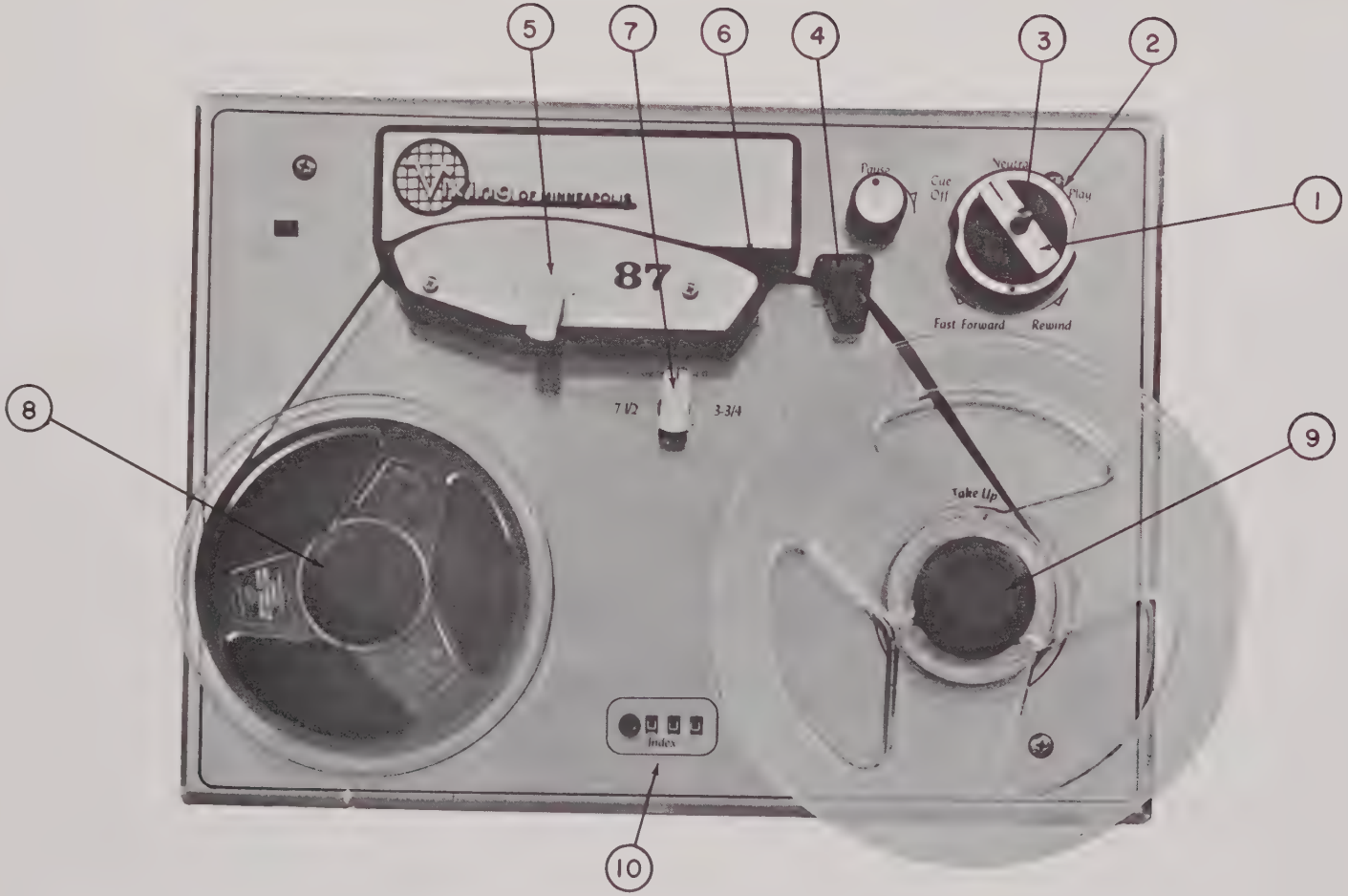


Figure 2B. Speech Accessory Unit, Tape Motion Control Panel

B6-106-124

2. SPEECH ACCESSORY UNIT

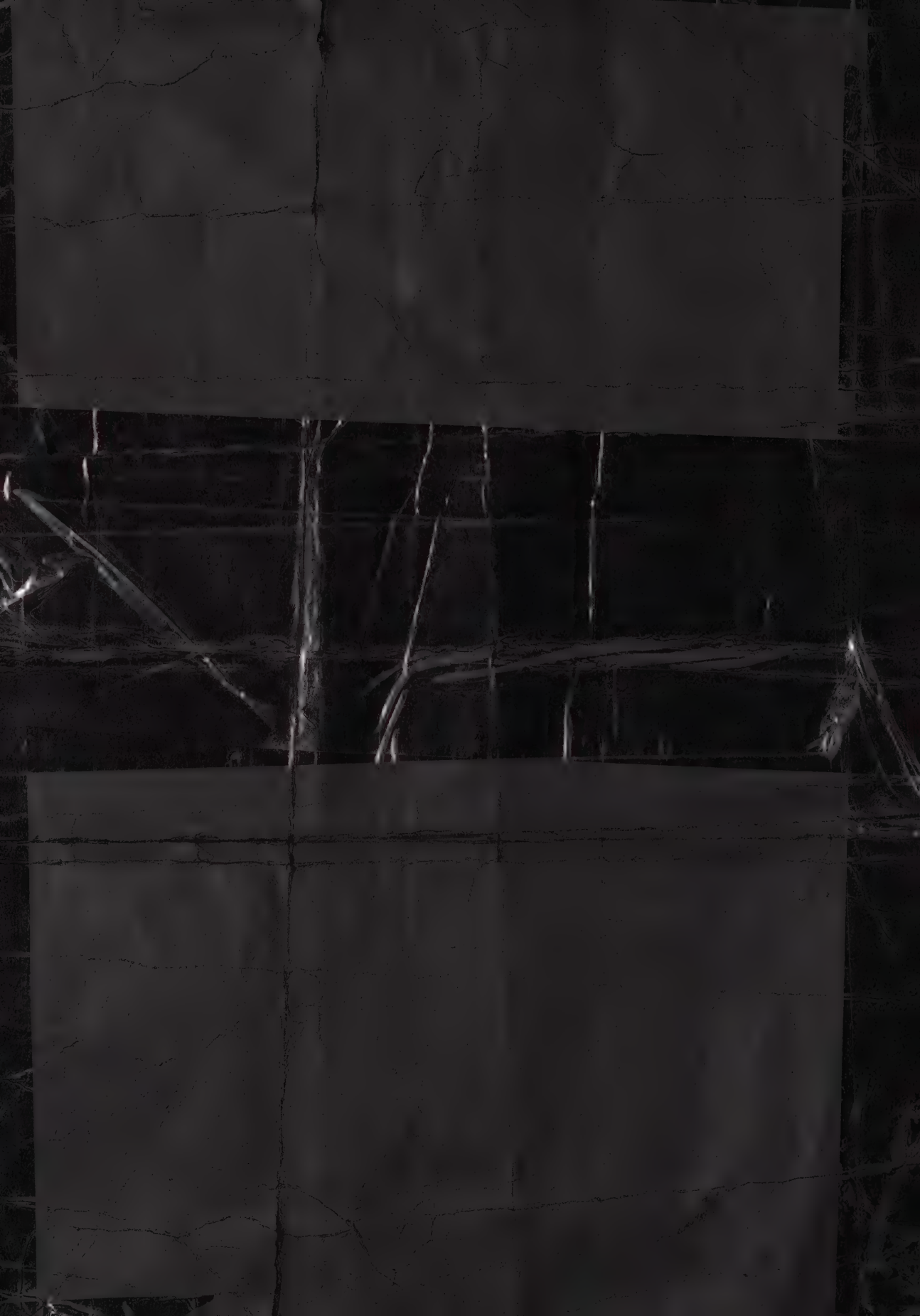
A. Speech Accessory Unit Tape Motion Control Panel

1. Center Bar

Play	Tape moves from left to right in normal forward (record and play).
Neutral	(Stop position) Full braking is applied. Tape is lifted from heads.
Cue	Reels are free to move by hand (for editing or precise positioning of the tape). Tape is in contact with heads.

2. Outer Ring

Fast Forward	Fast travel of tape from left to right.
Neutral	Full braking is applied.
Rewind	Fast travel of tape from right to left.



Use the Tape Motion Control at any time during operation. STOP the tape.... REWIND the tape to any point....FAST FORWARD the tape to a desired selection.. ...or CUE the tape by hand.

Tape Motion Controls are completely interlocked. Only one can be moved at a time; if one is displaced, the other cannot be moved until the first is returned to NEUTRAL.

3. Erase-Protek Button — Depress to record. The Erase-Protek Button will stay depressed only as long as the Tape Motion Bar is at PLAY. Any subsequent movement of the Tape Motion Control will release the Erase-Protek Button, thereby preventing any accidental erasure of your tapes.

CAUTION

Never press this button when playing recorded tapes.

4. Tape Run-Out Switch — Automatically shuts off Transport when tape is through or if it should break.

5. Head Shift Control — Positions the tape heads as follows:
   H for half-track (2-track) operation
   Q for quarter-track (4-track) operation

6.	Capstan	Propels tape at a constant speed.
7.	Tape Speed Control	Moves tape at 3-3/4 ips (inches per second) or at 7½ ips.

NOTE

Change tape speeds only when the capstan is turning (Tape Run-Out Switch pin moved downward).

8.	Supply Reel	Dispenses the tape in forward motion.
9.	Take-Up Reel	Collects the tape in forward motion.
10.	Digital Counter	Depress button to set at zero (000). Counter digits advance in proportion to the revolutions of the take-up reel and provide an index to a desired portion of a tape.

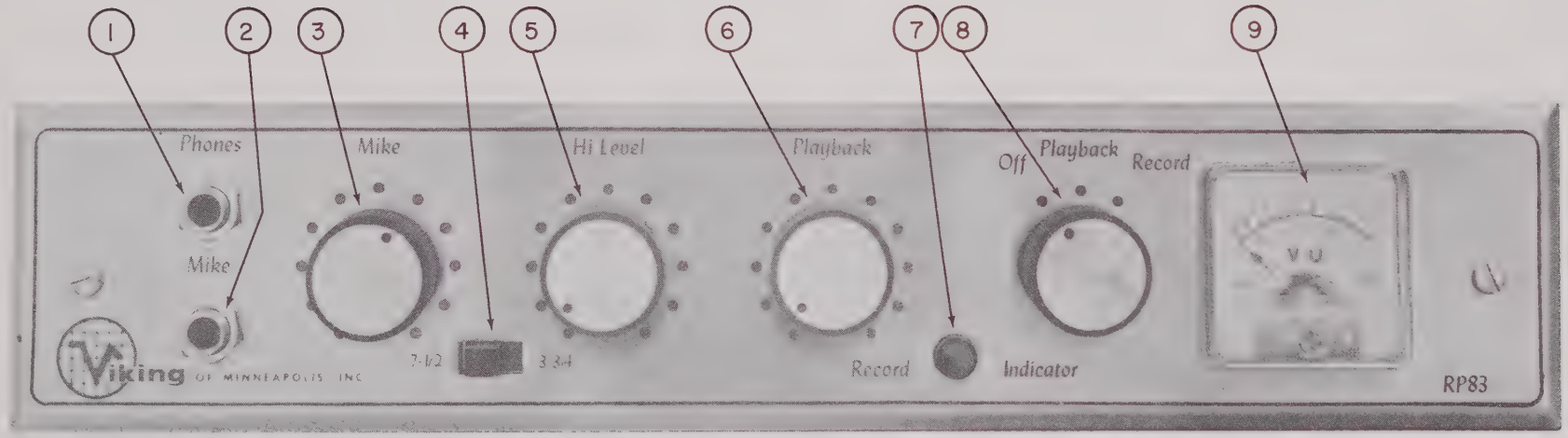


Figure 2C. Speech Accessory Unit, Front Panel

B. Speech Accessory Unit Front Panel Controls

1.	Phones	This jack is the output point to the headphone.
2.	Mike	This jack is the input point for the microphone.
3.	Mike	Controls input level from microphone.
4.	7-1/2 / 3-3/4	Slide switch provides tape equalization for 3-3/4 and 7-1/2 ips.
5.	Hi Level	Input level control for auxiliary input devices, e.g., phonograph.
6.	Playback	Output control for playback.
7.	Record Indicator	The red lamp indicates that recording is taking place.
8.	Off/Playback/ Record	Power is not supplied in Off position. Playback position plays back recorded material. Record position records material.
9.	VU Meter	Shows the level of the signal being recorded.

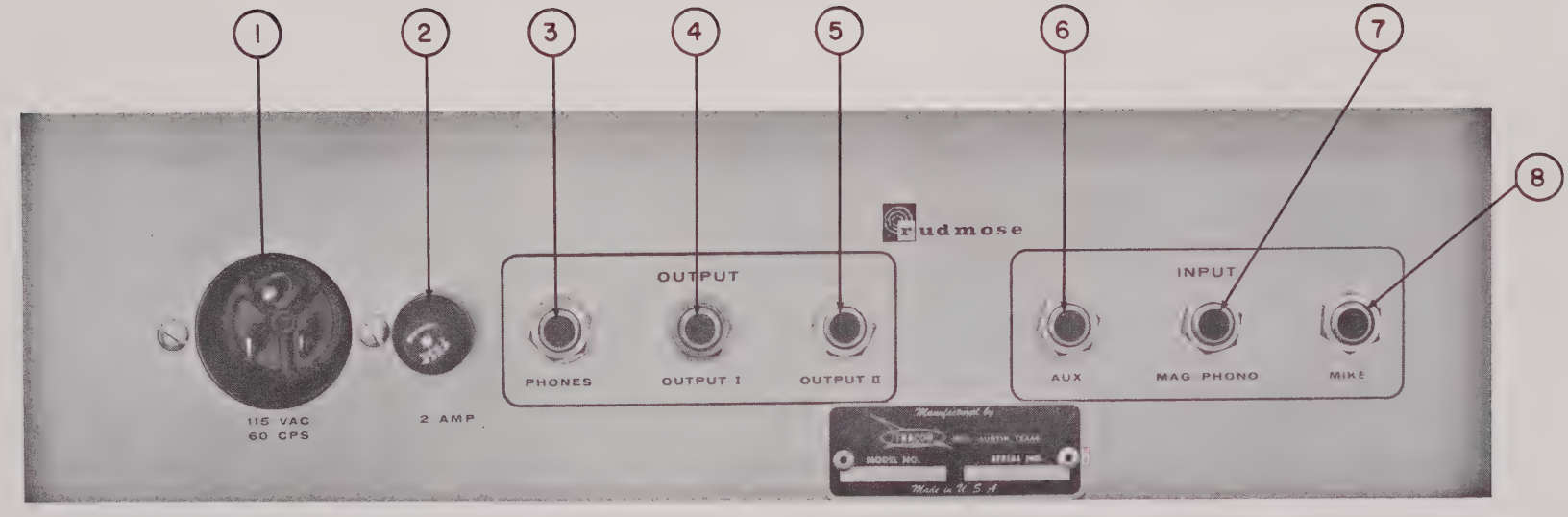


Figure 2D. Speech Accessory Unit, Rear Panel

C. Speech Accessory Unit Rear Panel Controls

1.	115 VAC 60 CPS	This socket is the power input point for the Speech Accessory Unit and is supplied with 115 VAC at 60 Hz.
2.	FUSE 2 AMP	This is the fuse holder for the active protective fuse.
3.	PHONES	This jack is the output to the earphones.
4.	OUTPUT I	This jack provides an output to speakers.
5.	OUTPUT II	This jack provides an output to speakers.
6.	AUX	This input jack provides for an auxiliary signal input.
7.	MAG PHONO	This input jack provides for a phonograph input.
8.	MIKE	This jack is the input for the microphone.

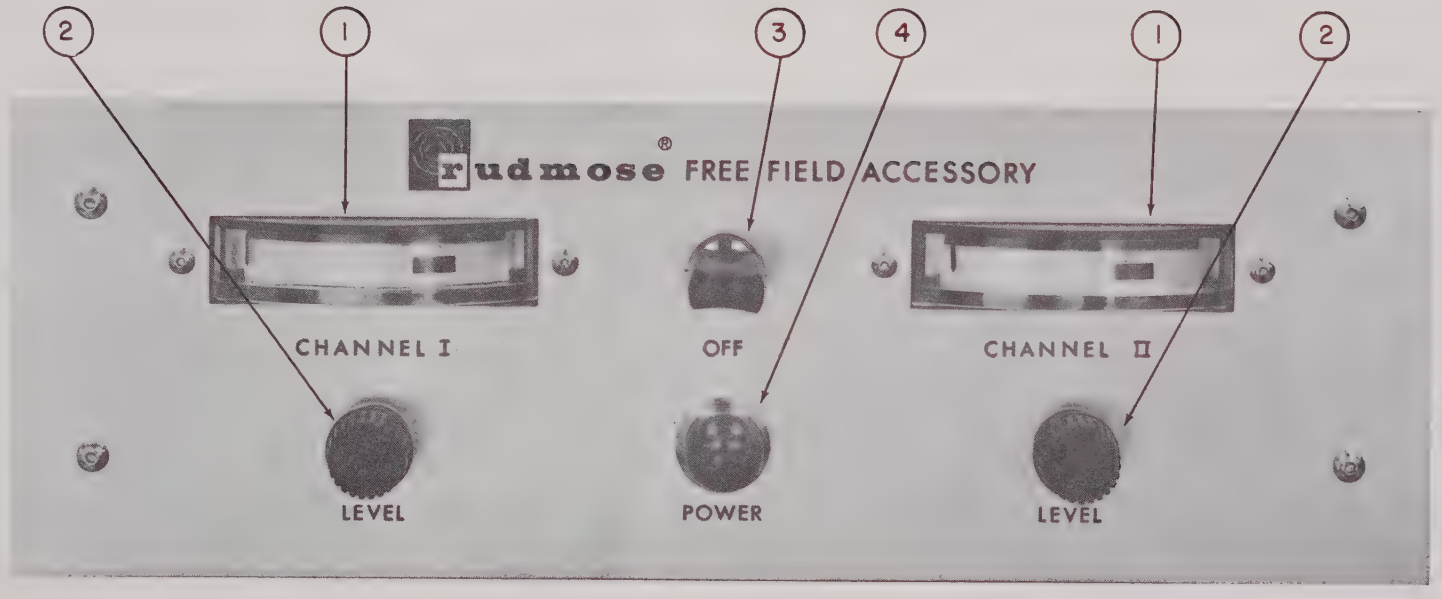


Figure 2E. FREE FIELD ACCESSORY Unit, Front Panel

3. FREE FIELD ACCESSORY UNIT

A. Free Field Accessory Front Panel Controls

1.	CHANNEL I/II	Monitors output level of amplifier.
2.	LEVEL	Adjusts the electrical output level.
3.	OFF	No power is supplied to unit in OFF position. Power input is supplied in center and up positions.
4.	POWER	Red light indicates when power is being supplied to the unit.

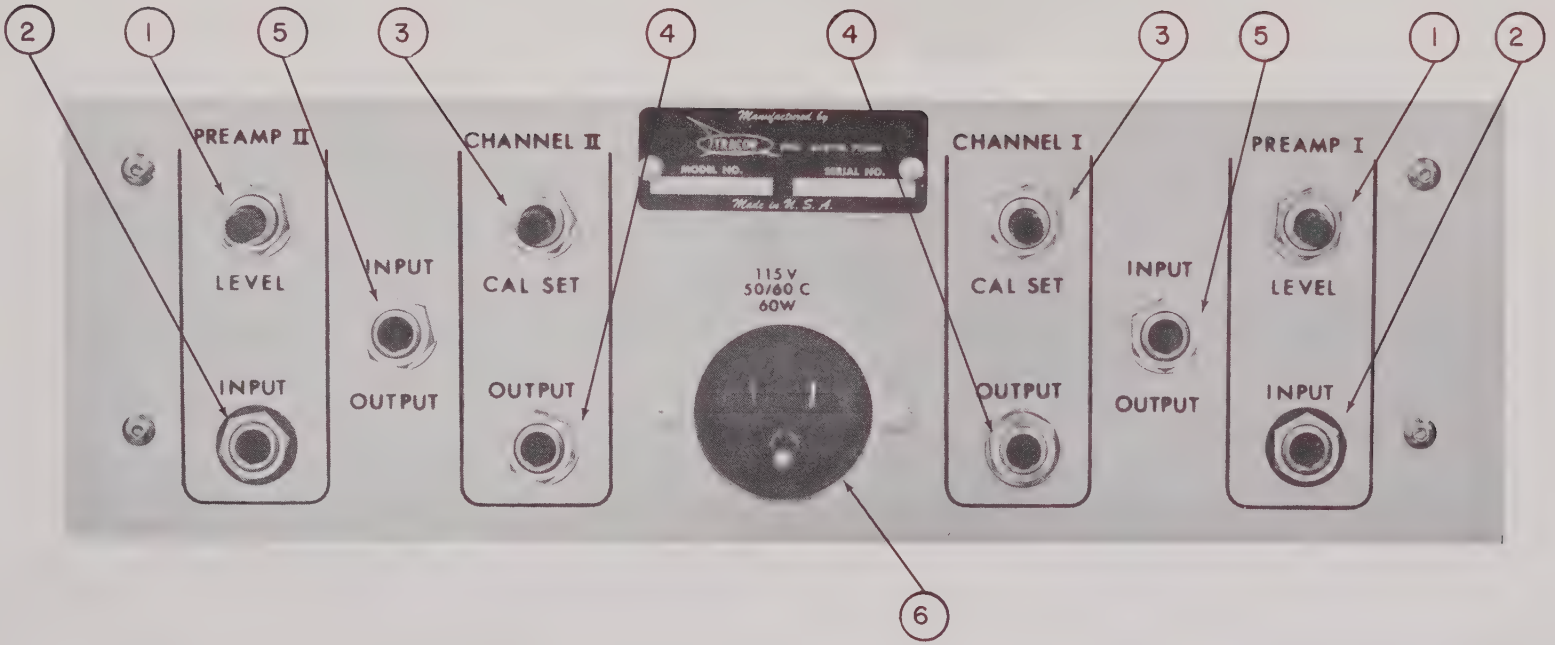


Figure 2F. Free Field Accessory Unit, Rear Panel

B. Free Field Accessory Rear Panel Controls

1.	PREAMP I/II LEVEL	Adjusts the electrical input level.
2.	PREAMP I/II INPUT	This jack permits access for an external signal input.
3.	CHANNEL I/II CAL SET	These controls are used to calibrate the Free Field Accessory CHANNEL I/II meters.
4.	CHANNEL I/II OUTPUT	This output jack is used for patch cable to speaker(s).
5.	INPUT/OUTPUT	This jack permits an input for bypassing PREAMP I/II or output jack for bypassing CHANNEL I/II amplifiers.
6.	115 V 50/60 C 60W	This socket is the power input point for the Free Field Accessory.

WARM-UP AND CALIBRATION PROCEDURES

Section 3

1. GENERAL OPERATING CHARACTERISTICS

A. Keep in mind the following characteristics of the ARJ-5:

1. Red knobs control AC power circuits, white knobs control output signals, and black knobs control the test characteristics.

2. The position of the audiogram table determines the frequency of the tone being presented - unless an external signal is presented. The FREQ HOLD switch will hold a certain frequency once it is selected by setting the table.

3. Only one intensity range, -10 to 90 dB (I.S.O.), is produced for 250 Hz, 7000 Hz and 8000 Hz signals regardless of the Master Control Békésy Range Switch position. The Auxiliary Electronic Switch attenuator switch always reads at least 20 dB high for these two signals. Since the -20 dB switch on the Auxiliary Electronic Switch module does affect these tones, the attenuator actually reads 40 dB high for 250 Hz, 7000 Hz and 8000 Hz (while the -20 dB switch is activated).

4. No signal will be produced while the TONE, Range (10 to 110/-10 to 90), or SUBJECT/MONITOR switches on the Master Control Békésy Module are in the center position.

5. Do not put two of the output control switches (BÉKÉSY, ELECTRONIC SWITCH, and MASKER) in the same position unless the test calls for two stimuli through the same input, i.e., during bone conduction tests, place the other two switches to one of the earphones and when conducting earphone tests place the other two switches in the BONE or B positions.

6. When any module is not is use, be certain that its attenuator, if any, is in the extreme left position (down for the SISI pulse switches) and that the function switches are all centered.

7. The maximum calibrated bone conduction intensity is 40 dB in the -10 to 90 dB range as indicated by the double line on the audiogram cards, and 60 dB in the 10 to 110 dB range (500-4000 Hz).

8. Always keep an audiogram card on the table to prevent accidental stylus damage to the table.

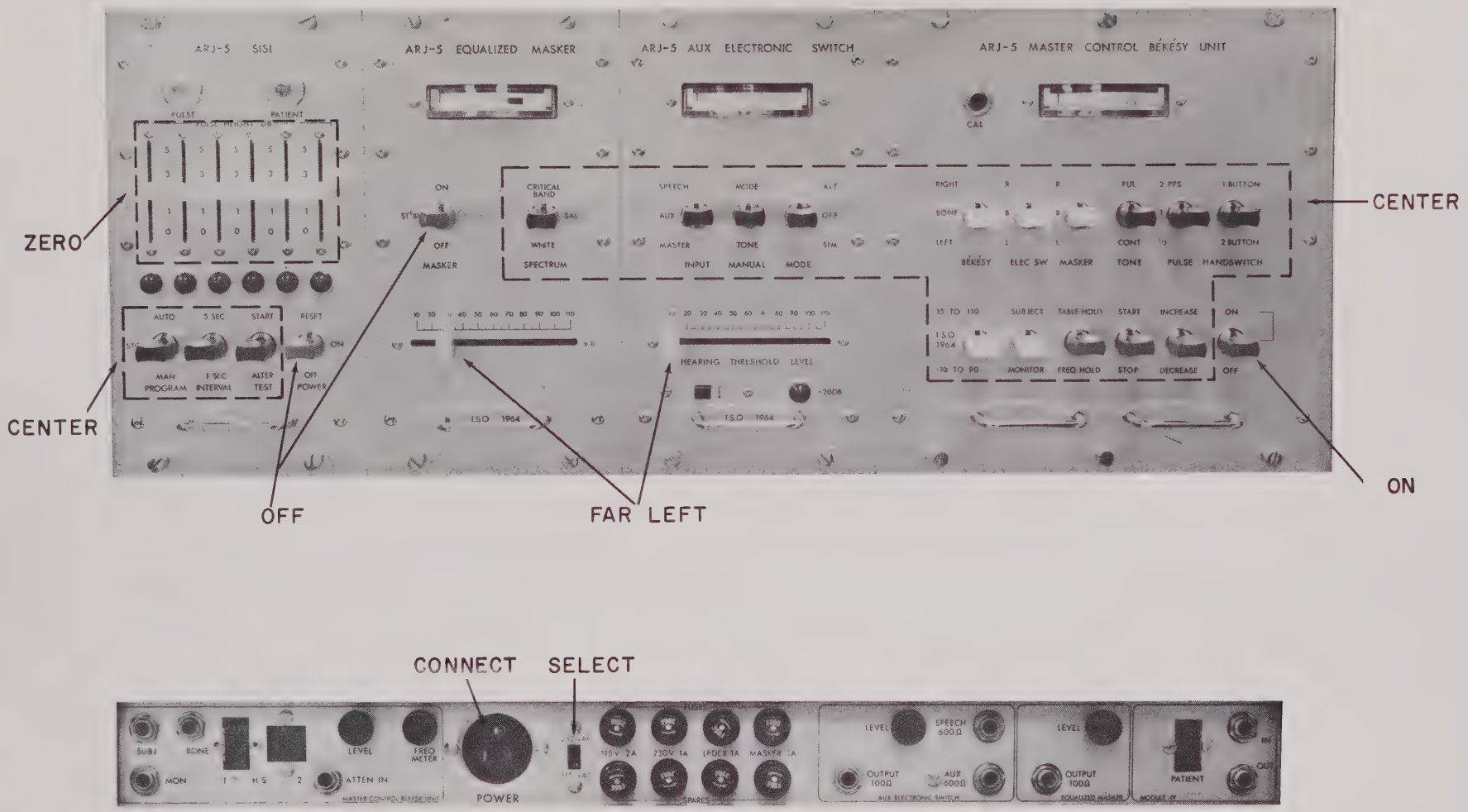


Figure 3A. Warm-up

2. The following procedures are for the total instrument. It is not necessary either to WARM-UP or to CALIBRATE modules which are not to be used during the testing period.

A. WARM-UP

1. Be certain the 230 VAC/115 VAC switch is set for the voltage corresponding to the line power to be used.

2. Place the Auxiliary Electronic Switch and Equalized Masker attenuator lever to their far left positions and the SISI PULSE HEIGHT levers to their zero positions.

3. Place the Master Control Békésy ON/OFF, the Equalized MASKER, and the SISI POWER switches to their OFF positions.

4. Place all the other three-position switches in their center positions.

5. Connect the power cord to the POWER socket in the rear panel and the power outlet.

6. Set the attenuation rate switch on the left of the audiogram table to the desired rate (2.5 dB/sec. or 5.0 dB/sec.).

7. Switch the Master Control Békésy ON/OFF switch to ON.

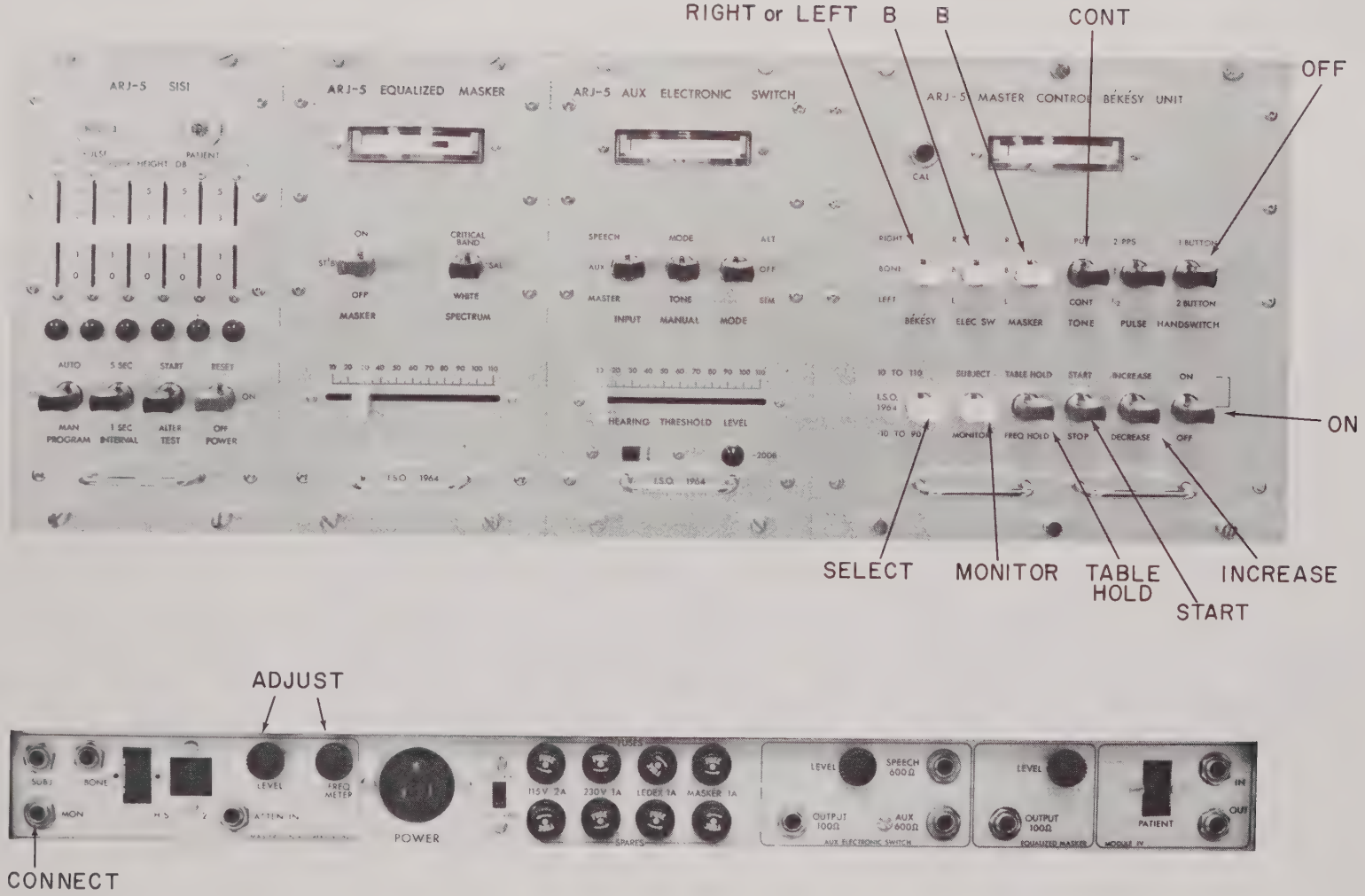


Figure 3B. MASTER CONTROL BÉKÉSY UNIT Calibration

B6-106-128 A

B. MASTER CONTROL BÉKÉSY UNIT CALIBRATION

After completion of WARM-UP proceed as follows:

1. Connect the monitor earphones to the rear panel jack labeled MON.

2. Press the table release knob and pull out the audiogram table.

3. Fit an audiogram card onto the pins.

4. Press the table release knob and push the table back until the stylus is in the 500 Hz block of the audiogram card.

5. Place the Master Control Békésy controls in the following positions:

BÉKÉSY - - - - - - - - - - - -Either RIGHT or LEFT
ELEC SW- - - - - - - - - - - -B
MASKER - - - - - - - - - - - -B
TONE - - - - - - - - - - - - -CONT
PULSE- - - - - - - - - - - - -Any position
HANDSWITCH - - - - - - - - - -OFF
Range (10 TO 110/-10 TO 90)- -Either 10 TO 110 or -10 TO 90
SUBJECT/MONITOR- - - - - - - -MONITOR
TABLE HOLD/FREQ HOLD - - - - -TABLE HOLD

6. Place the START/STOP switch to START. (Switch will return to the center position.)

7. Place INCREASE/DECREASE switch to INCREASE until the 500 Hz tone is identified in the earphones. (Switch will return to center position when released.)

8. If the Master Control Békésy meter does not read 500 Hz, adjust the Master Control Békésy FREQ METER control on the rear panel until it does.

9. If the Master Control Békésy meter does not read within the SET bracket while the CAL button is depressed, adjust the Master Control Békésy LEVEL control until it does. (Be certain the CAL button is depressed and that the stylus is <u>not</u> in the extreme left (OFF) position during the adjustment.)

10. Place the START/STOP switch to STOP.

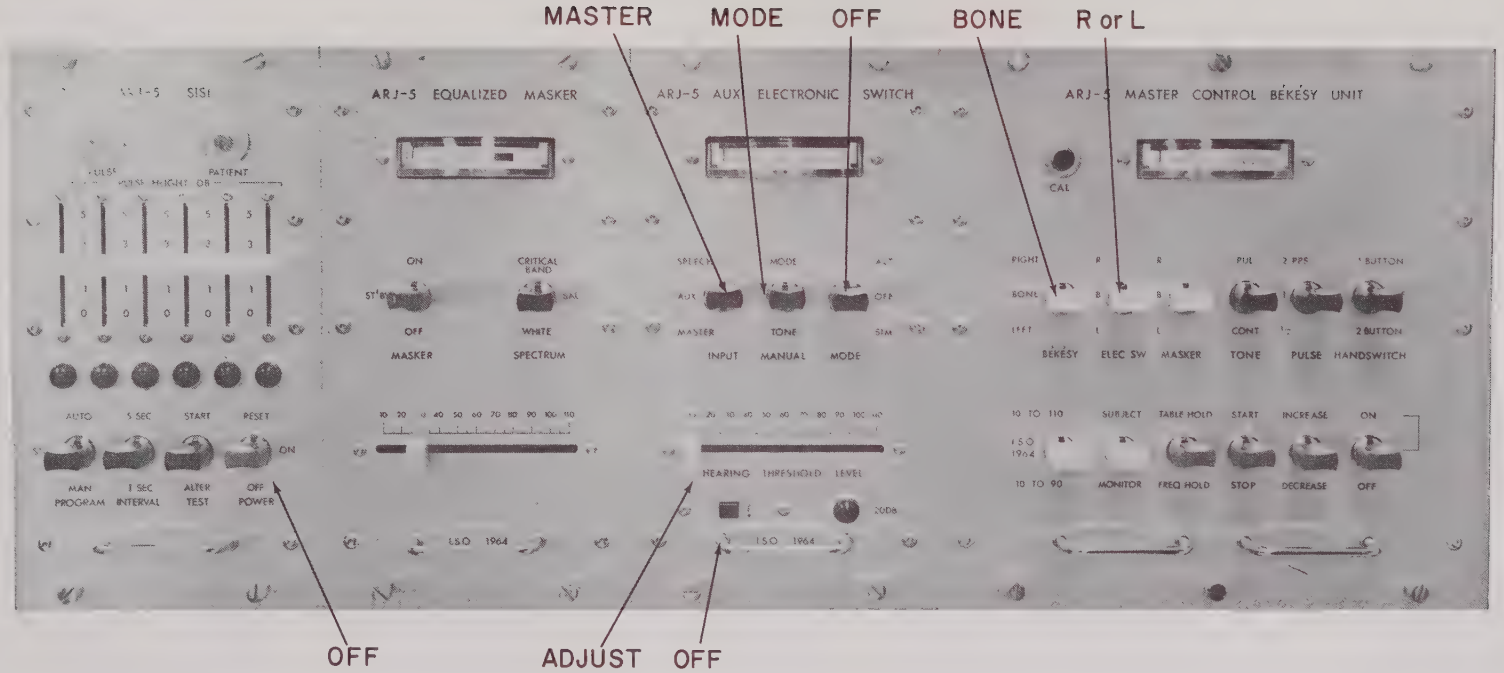


Figure 3C. AUX ELECTRONIC SWITCH Calibration

C. AUXILIARY ELECTRONIC SWITCH CALIBRATION

After completion of WARM-UP and Master Control Békésy CALIBRATION above, if the Auxiliary Electronic Switch Module is to be used for manual presentation of a pure tone test, proceed as follows:

1. Place the Master Control Békésy BÉKÉSY switch to BONE.

2. Place the Master Control Békésy ELEC SW switch to either R or L.

3. Place the switches on the Auxiliary Electronic Switch panel as follows:

   INPUT ----------MASTER
   MANUAL ----------MODE
   MODE ----------OFF
   -20 DB ----------off (light will not be on)

4. Increase the sound intensity with the HEARING THRESHOLD LEVEL attenuator until the 500 Hz tone is identified in the earphone.

5. Adjust the Auxiliary Electronic Switch LEVEL control on the rear panel until the Auxiliary Electronic Switch meter reads zero.

6. Return the MANUAL switch to center position.

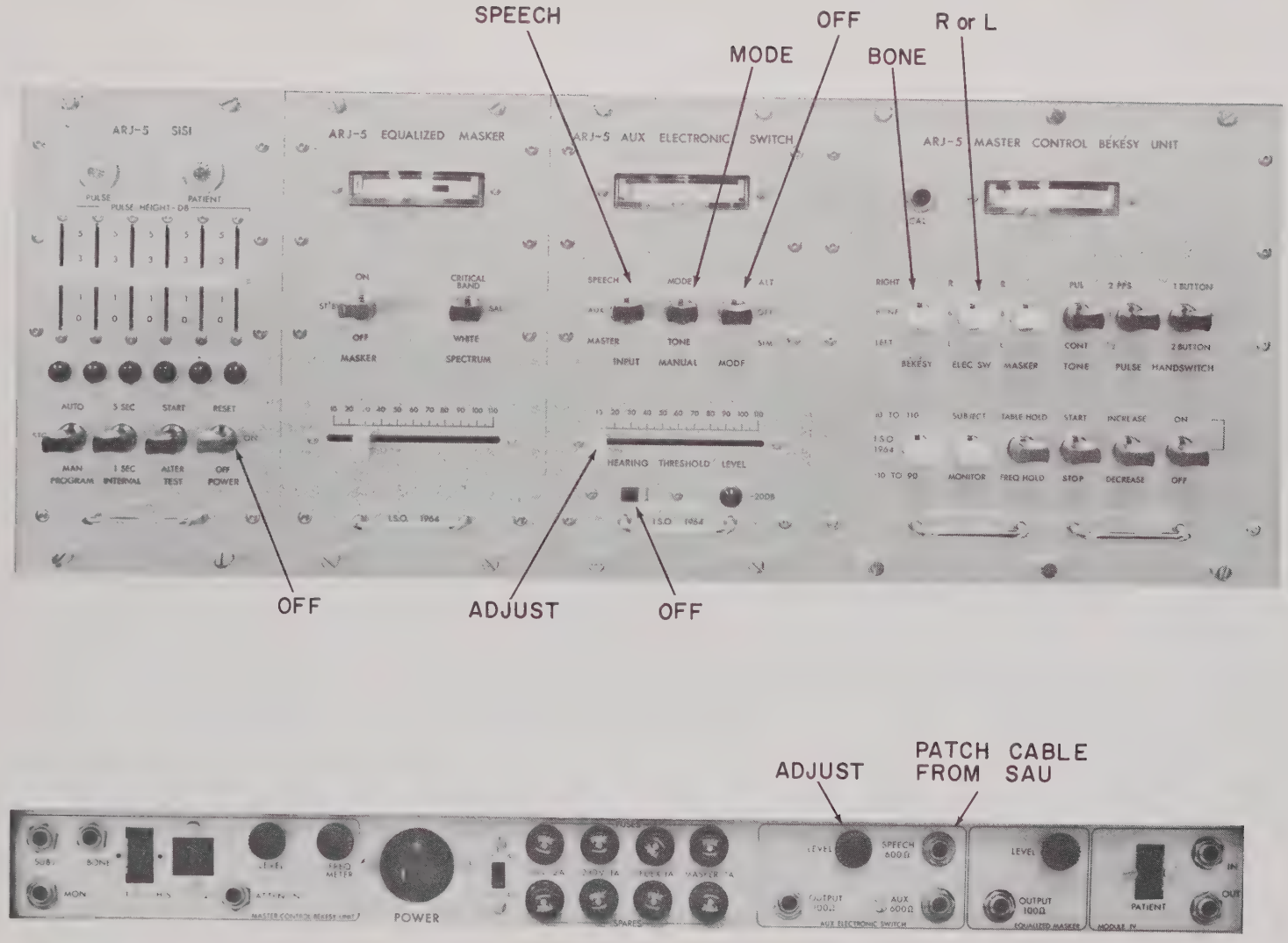


Figure 3D. AUX ELECTRONIC SWITCH Speech Calibration

B6-106-125A

D. Auxiliary Electronic Switch Speech Calibration

If the Auxiliary Electronic Switch is to be used for presentation of a speech test, proceed as follows:

1. Place the Master Control Békésy BÉKÉSY switch to BONE.

2. Place the Master Control Békésy ELEC SW switch to either R or L.

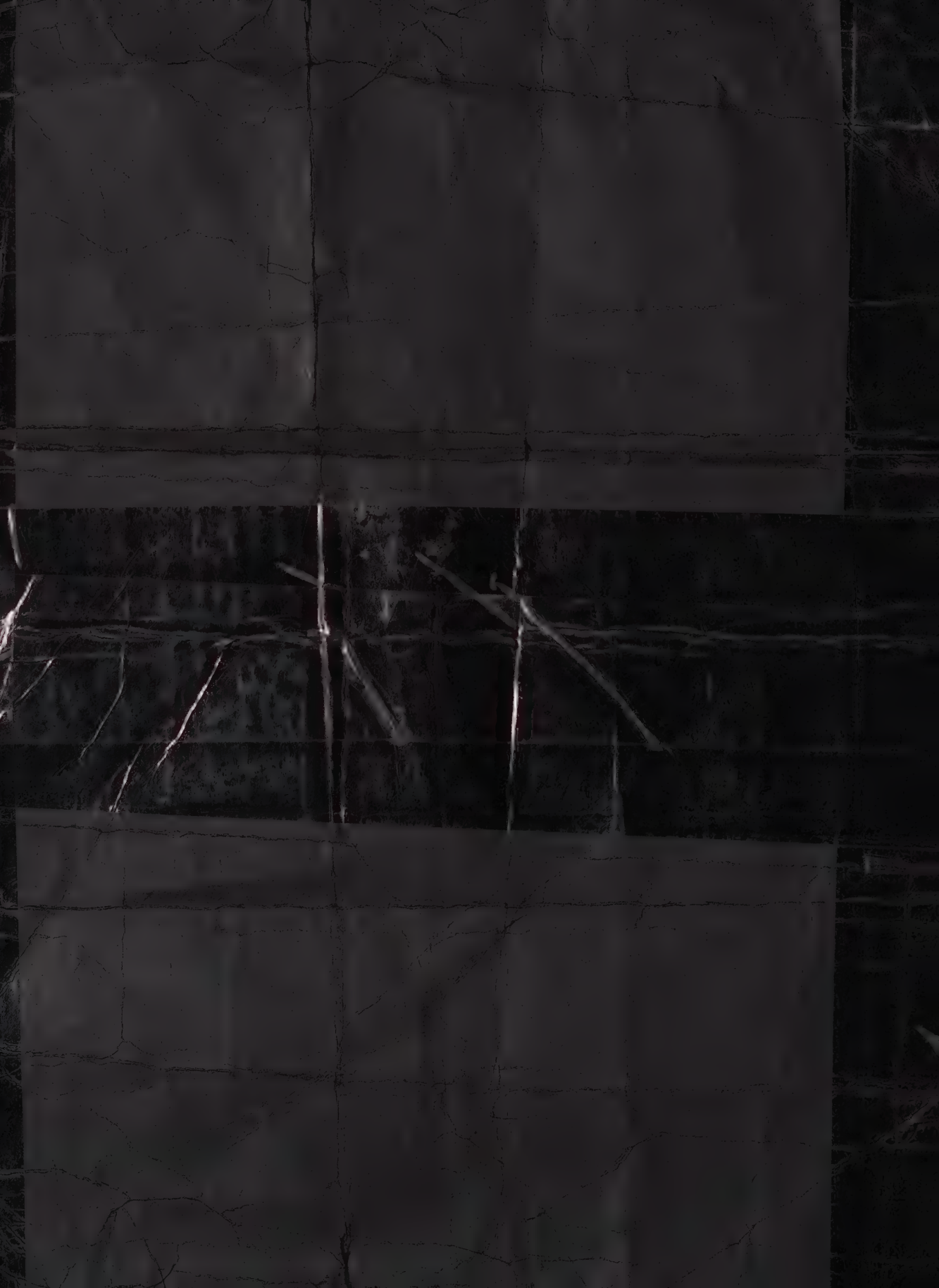
3. Connect the Speech Accessory Unit to the SPEECH jack on the Auxiliary Electronic Switch rear panel.

4. Place the Auxiliary Electronic Switch panel controls as follows:

INPUT ----------SPEECH
MANUAL----------MODE
MODE ----------OFF
-20 DB ----------off

5. Start the Speech Accessory Unit (see Section 2).

6. Set the HEARING THRESHOLD LEVEL attenuator until speech is identified in the earphones.



7. Adjust the Auxiliary Electronic Switch LEVEL control on the rear panel until the average reading of the Auxiliary Electronic Switch meter is zero.(The needle will oscillate since speech is not produced at a constant intensity.)

8. Return the MANUAL switch to center position.

NOTE

One or the other of the Auxiliary Electronic Switch calibrations can be made at any given time, but not both. If the type of input into the Auxiliary Electronic Switch unit is changed, so must the calibration be changed.

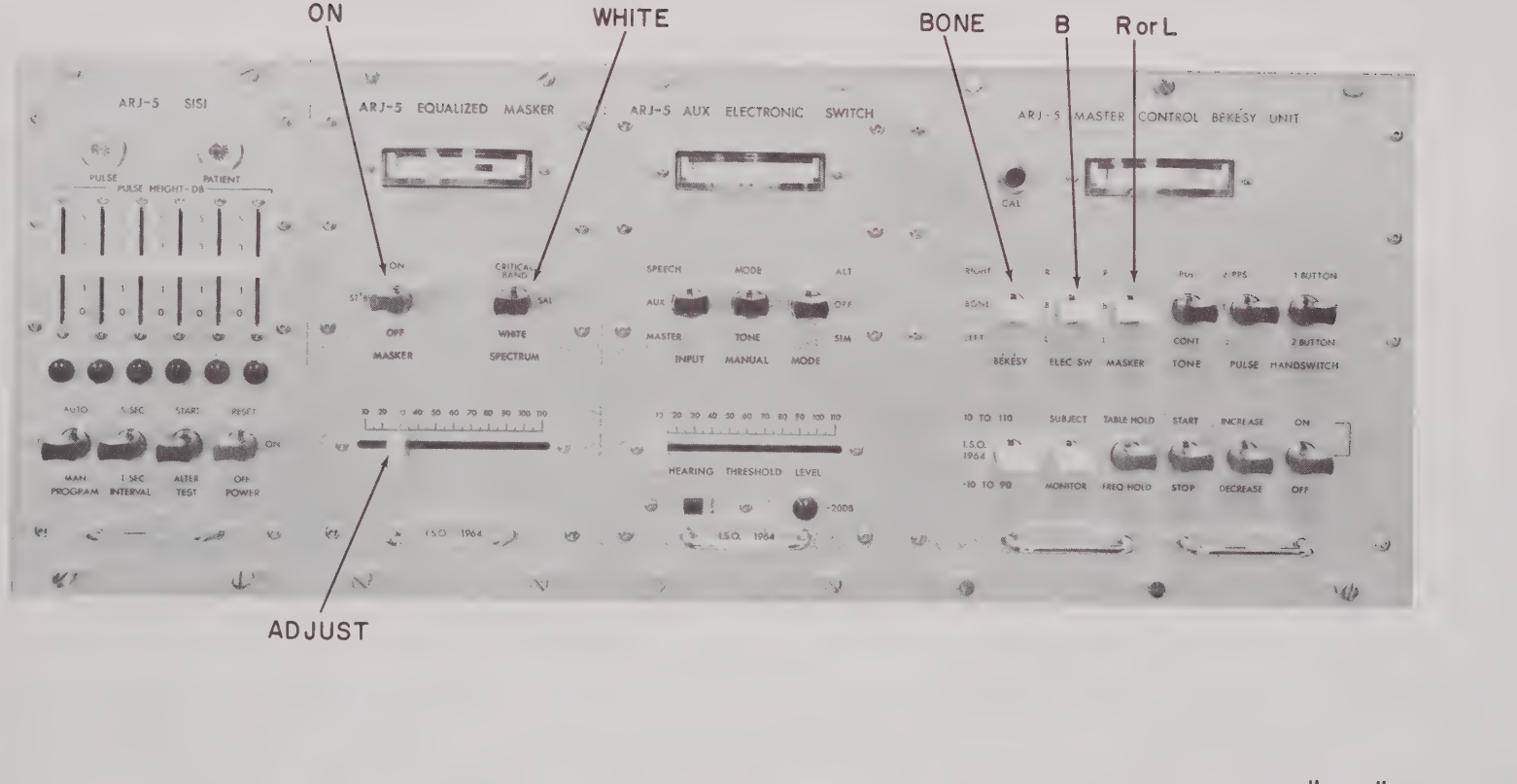


Figure 3E. EQUALIZED MASKER Calibration

B6-106-125 B

E. EQUALIZED MASKER CALIBRATION

After completion of WARM-UP and Master Control Békésy CALIBRATION, proceed as follows:

1. If Auxiliary Electronic Switch CALIBRATION (either function) has been performed, return the Auxiliary Electronic Switch module controls to their center positions.

2. Place the Master Control Békésy BÉKÉSY and ELEC SW switches to BONE.

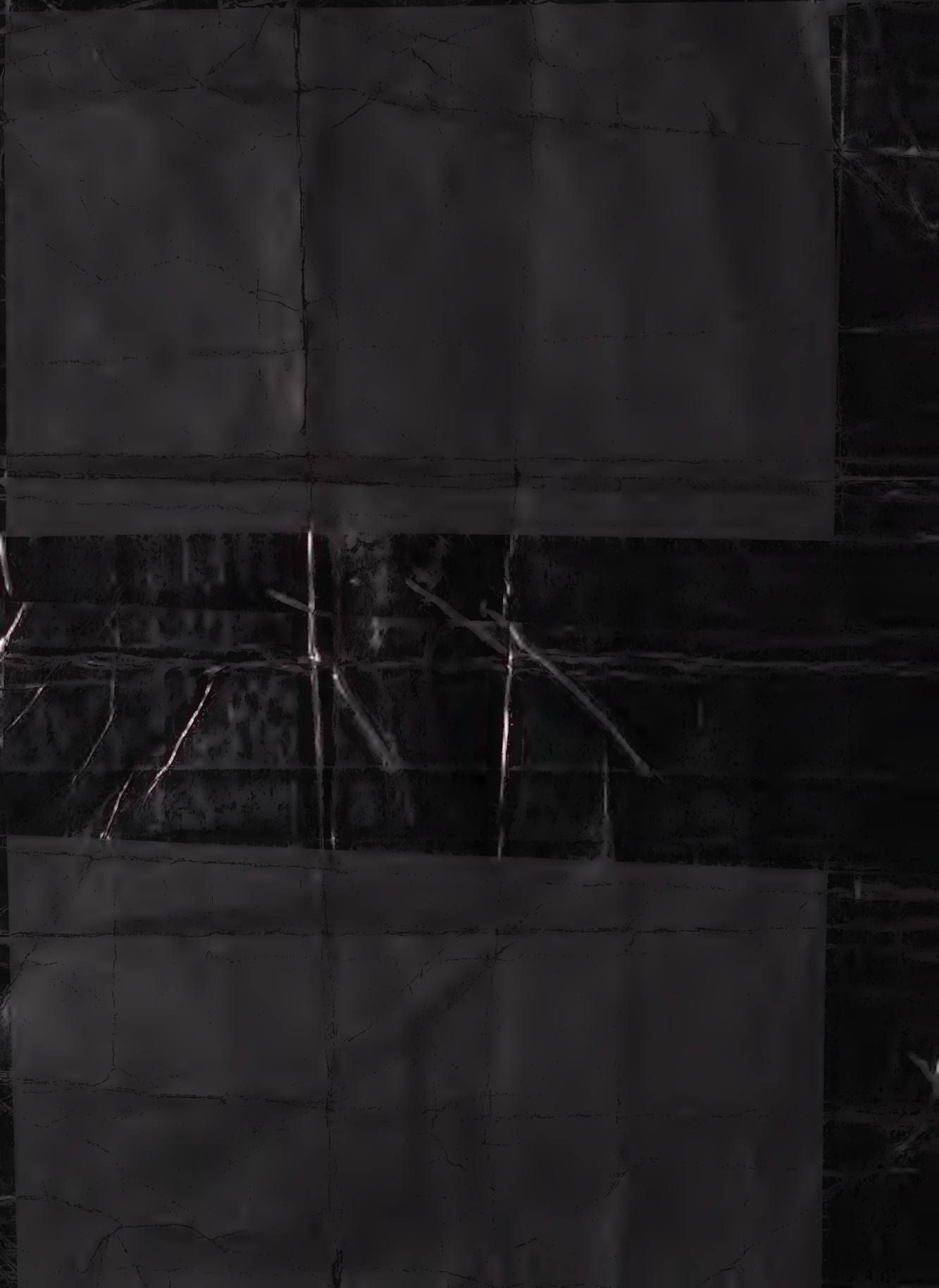
3. Place the Master Control Békésy MASKER switch to either R or L.

4. Place the Equalized Masker MASKER switch from ST'BY to ON.

5. Place the SPECTRUM switch to WHITE.

NOTE

Do not make this calibration
in any SPECTRUM position
other than WHITE.



6. Adjust the Equalized Masker attenuator lever until the white noise is identified in the earphone.

7. If the Equalized Masker meter does not read in the SET zone, adjust the Equalized Masker LEVEL control on the rear panel until it does.

8. Return the MASKER switch to ST'BY.

Figure 3F. FREE FIELD ACCESSORY Calibration

E. FREE FIELD ACCESSORY CALIBRATION

1. Turn all controls full counterclockwise and power switch to OFF.

2. Connect speaker(s) to amplifier output(s).

NOTE

If only one channel is to be used, the other amplifier channel OUTPUT need not be loaded.

3. Determine the level of the source to be presented to the Free Field Accessory unit and use appropriate input.

   a. Levels of one Volt or over (high-level) should connect between ring and sleeve in the INPUT/OUTPUT plug.

   b. Levels of from 5 mV to 1 Volt (low-level) should connect between tip and sleeves of preamplifier input plug.

   c. A one Volt maximum preamplifier output is provided between tip and sleeve of INPUT/OUTPUT plug if signal processing at a higher level is wanted.

4. If a high-level source signal is used the front LEVEL control only is used to vary output level.

5. If a low-level source signal is used adjust PREAMP I LEVEL control, then adjust the front panel LEVEL control to vary output level to the SET area on meter.

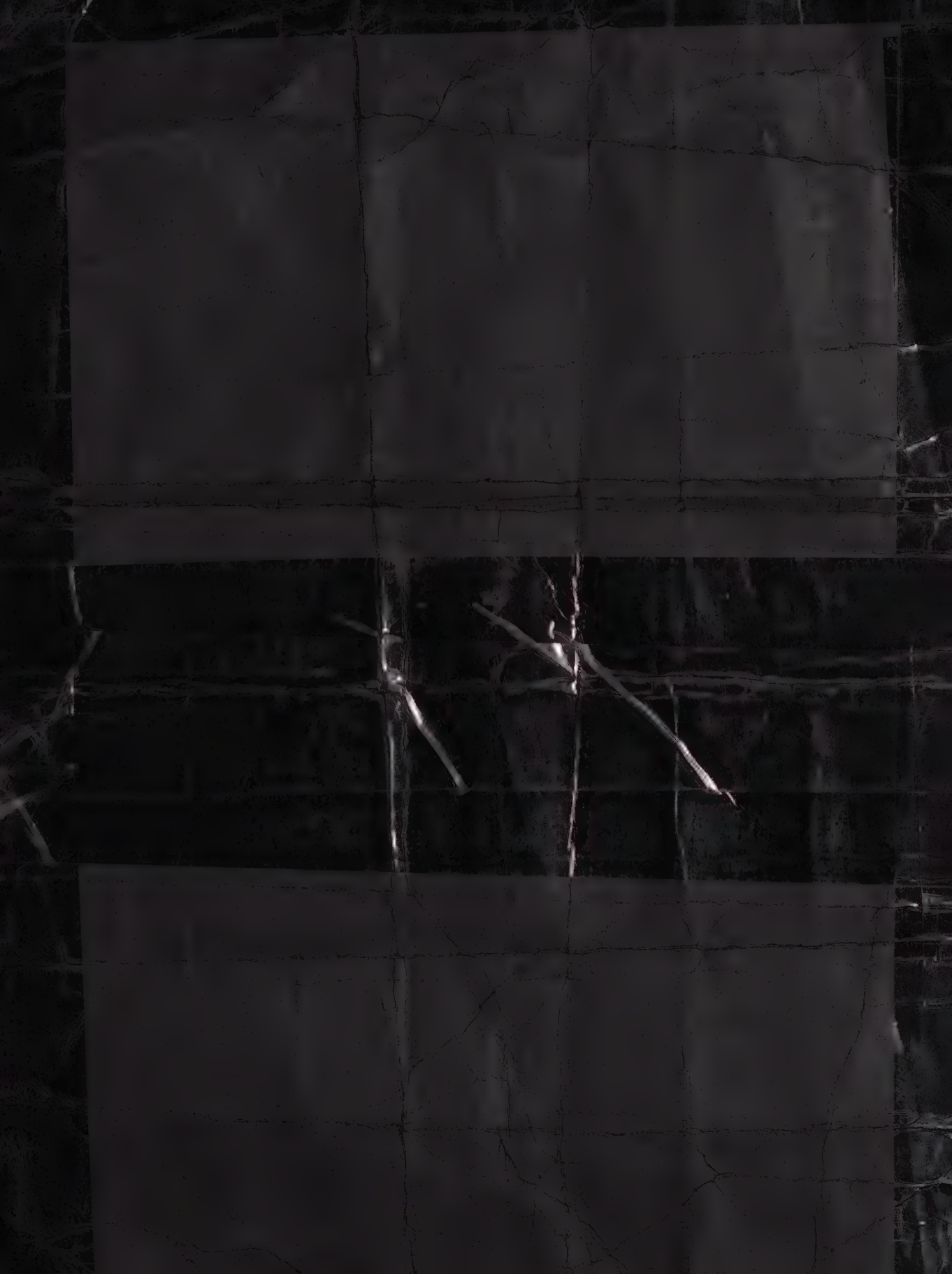
PURE TONE - AIR CONDUCTION

Section 4

Determination of thresholds
for Pure-tone

References:

Davis & Silverman - Chapter 7
Glorig - pp. 110-115
Hirsh - Chapter 4
Langenbeck - pp. 20-23
Newby (1958) - pp. 71-80
O'Neill & Oyer - pp. 62-64
Portmann & Portmann - pp. 5-8
Sataloff - pp. 293-303



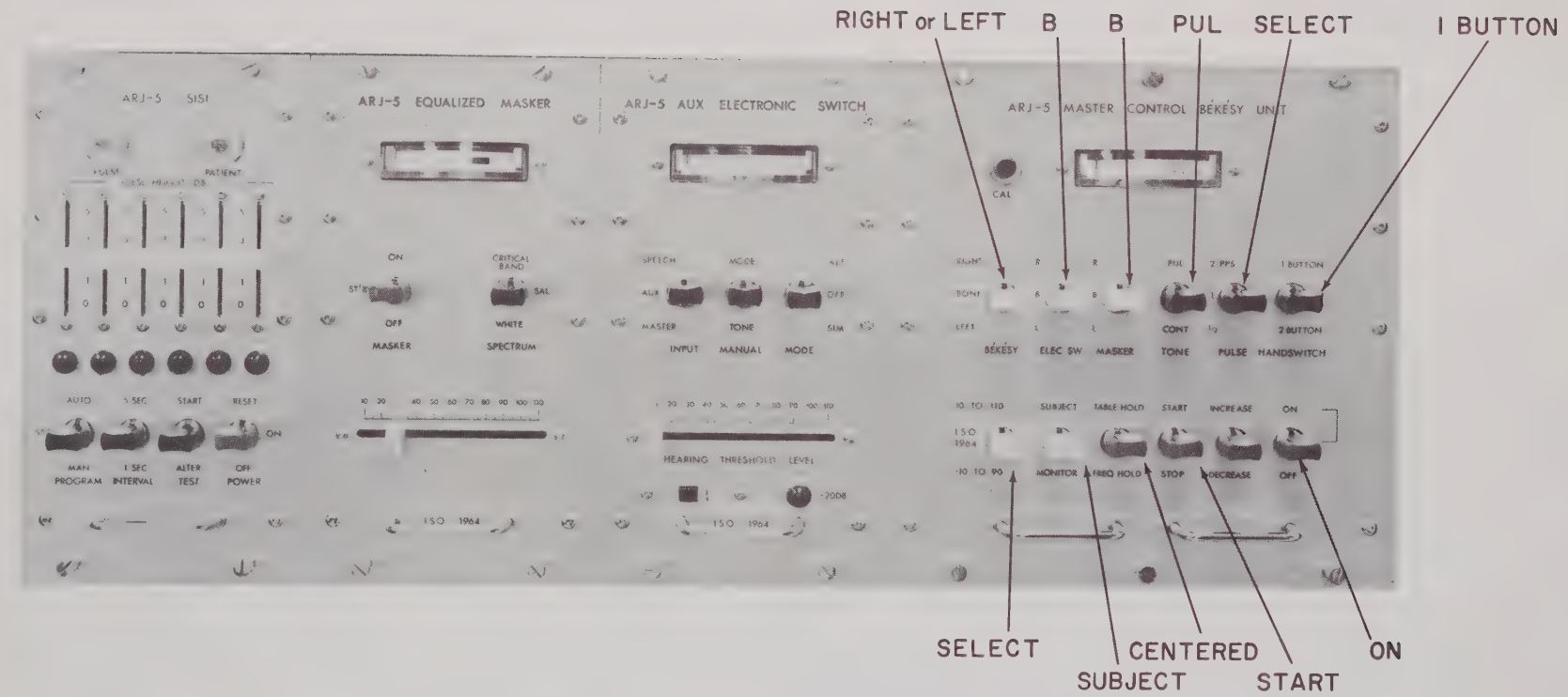


Figure 4. Pure Tone Air Conduction

B6-106-129 A

Section 4

1. Set up as shown:

   A. Set table at desired frequency position.

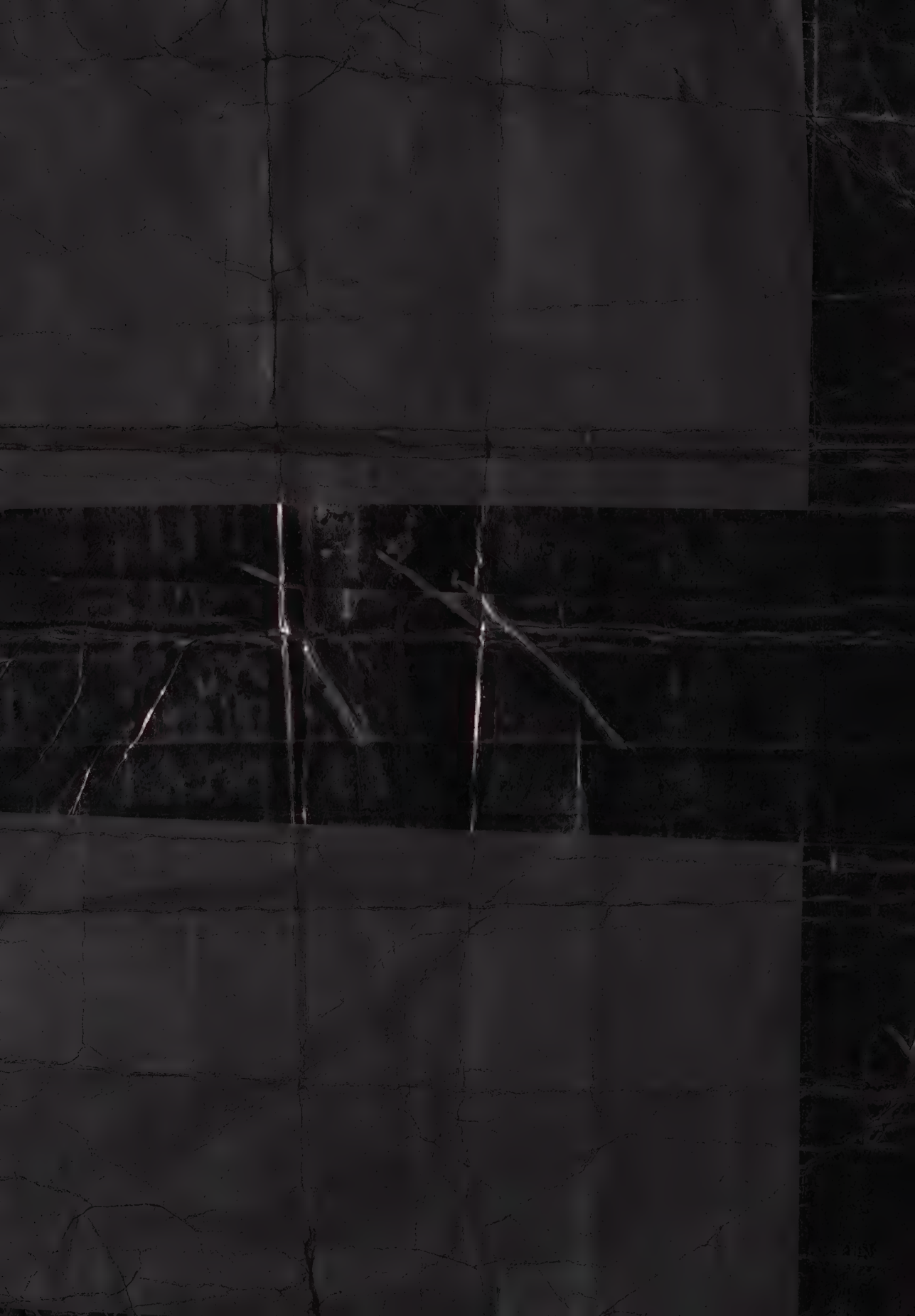
   B. Plug one button handswitch into Master Control Békésy 1 —— H.S. (rear panel) input jack.

   C. Place the TABLE HOLD/FREQ HOLD switch to TABLE HOLD until the subject hears the tone, and begins to make satisfactory tracings.

   D. When the subject responds satisfactorily to the tone, return the TABLE HOLD switch to the central position, and continue the test.

NOTE

Repeat of steps C and D may be necessary during a test for subjects who exhibit a sharp rise in threshold at some test frequency. Due to the attenuation rate (2.5dB/sec) of the Békésy unit, the major portion of a given threshold tracing could be lost during the subject's attempt to hear the tone.



2. Clinical Procedure:

   A. Inform the subject that he will hear a pulsed tone and that the frequency or tone will change at 30 second intervals. He is to press and hold the hand-switch button as soon as he hears the tone and release the button as soon as he no longer hears the tone.

   B. Test the better ear first if the subject indicates a difference in sensitivity in the two ears. Otherwise, test the right ear first.

   C. This test may be performed manually by selecting the frequency with the position of the audiogram table and reading it from the Master Control Békésy meter. The intensity is controlled by the Auxiliary Electronic Switch attenuator.

   D. Békésy testing can be performed as rapidly as manual A/C testing by permitting the subject to cross his threshold two or three times, and then changing the frequency by manually moving the table. In this manner a written record is still obtained, yet the test time is reduced to just a few minutes. A few practice trials should convince the operator of the merits of this technique.

   E. When A/C levels in both ears are 40 dB or greater, it is good audiometric practice to check the thresholds at 1000 Hz for each ear with masking in the opposite ear. This will ensure that cross-head stimulation is not yielding false thresholds. (See Section 5)

3. Interpretation:

   A. If the sweeps are 10 dB or less, score the audiogram by drawing a line through the center of the sweeps and recording to the nearest 5 dB (see figure A, 250 - 5000 Hz).

   B. If the sweeps are greater than 10 dB, average the readings for the peaks and add 5 dB to obtain the threshold reading (see figure B).

C. If the sweeps in the low frequencies are 10 dB or less, and the sweeps in one or more of the high frequencies are more than 10 dB, average the valleys of the wide sweeps to the nearest 5 dB and subtract 10 dB from that figure (see figure A). Score the low frequency sweeps according to step A.

Reviewers' Comments:

"A demonstration of the handswitch procedure may be required for children or mentally retarded subjects."

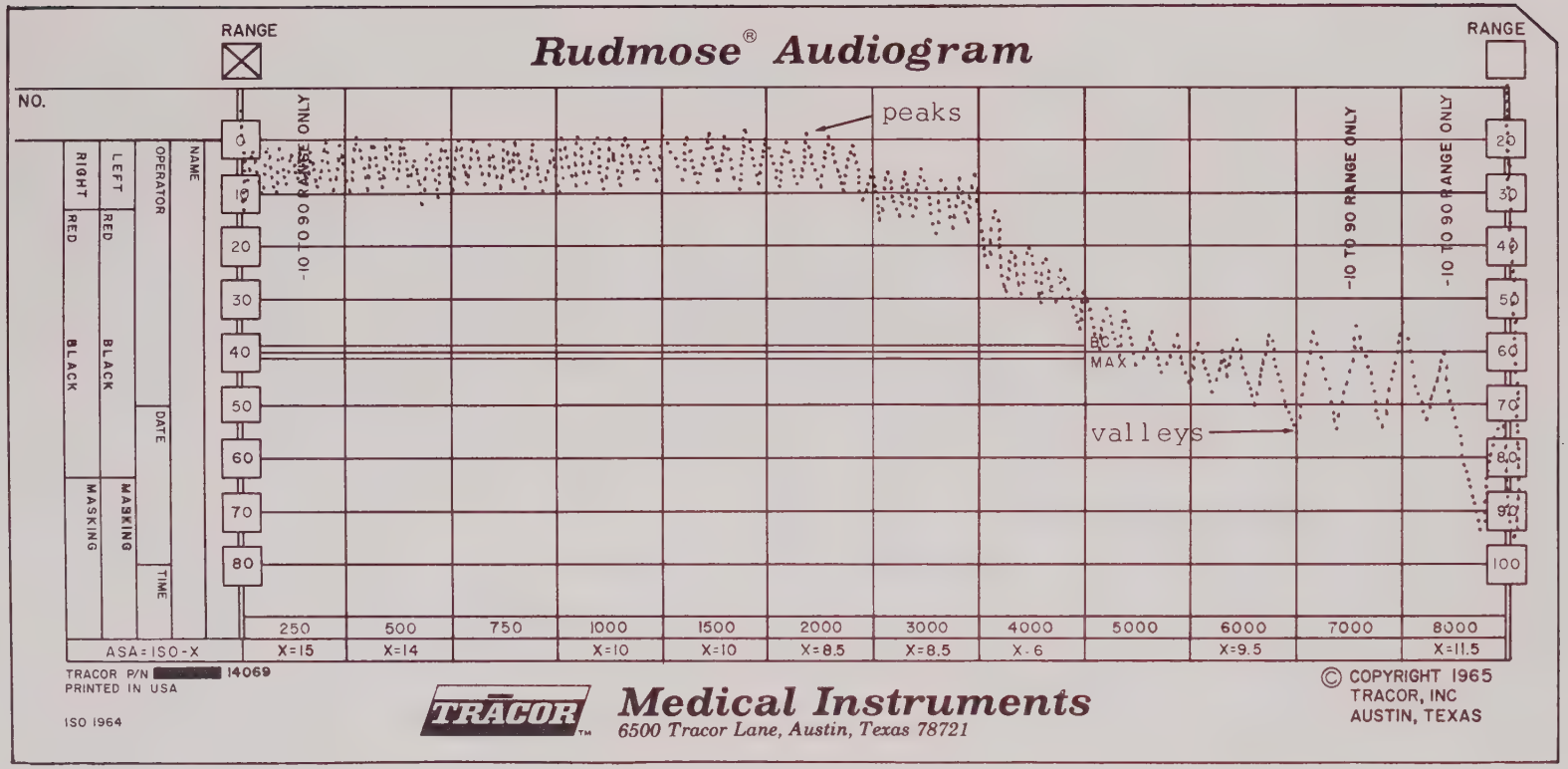


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Figure A

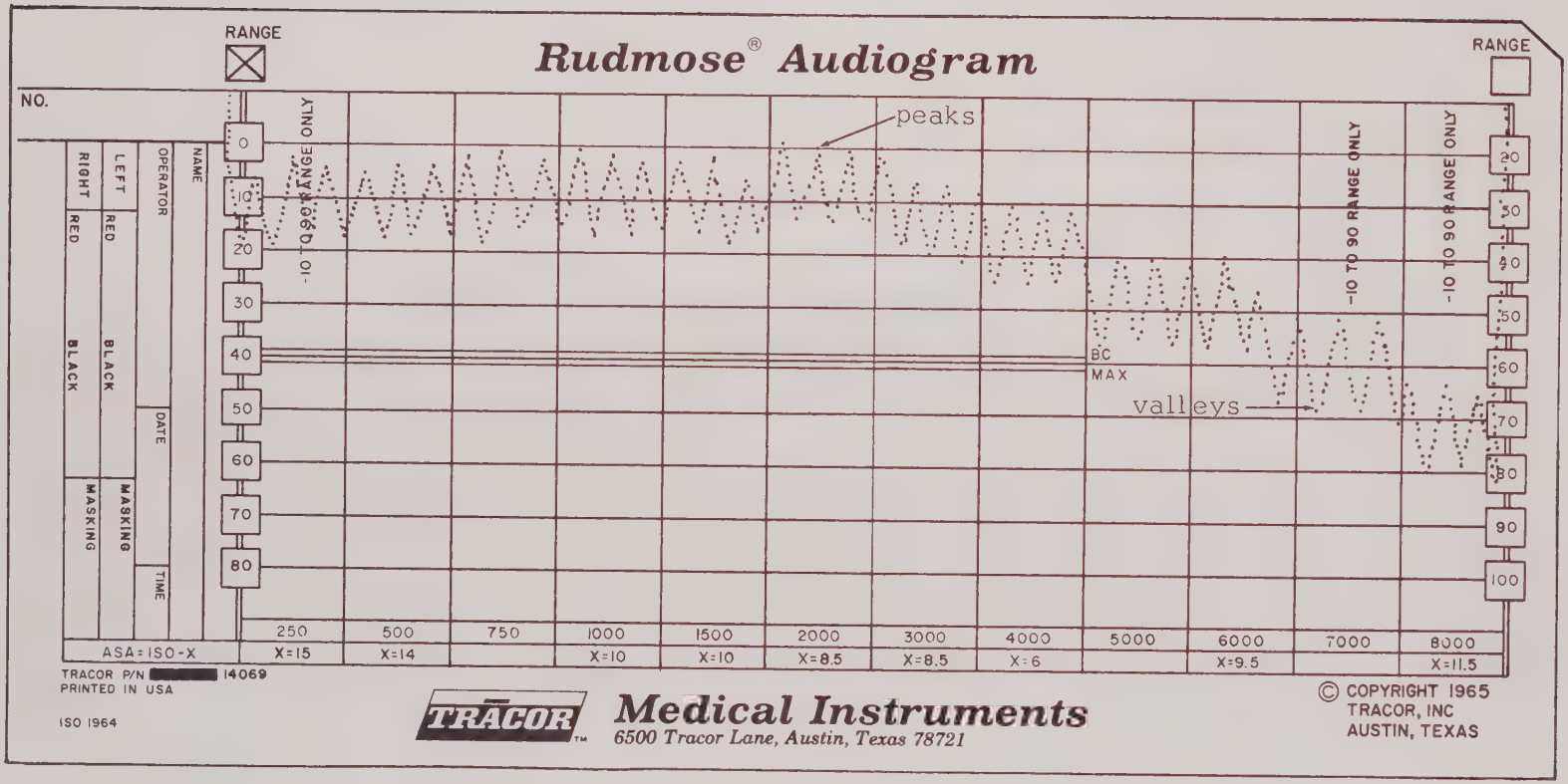
Rudmose® Audiogram
RANGE
RANGE
NO.
RIGHT
RED
BLACK
MASKING
LEFT
RED
BLACK
MASKING
OPERATOR
DATE
TIME
NAME
-10 TO 90 RANGE ONLY
0
10
20
30
40
50
60
70
80
peaks
BC
MAX
valleys
-10 TO 90 RANGE ONLY
-10 TO 90 RANGE ONLY
20
30
40
50
60
70
80
90
100
250
500
750
1000
1500
2000
3000
4000
5000
6000
7000
8000
ASA=ISO-X
X=15
X=14
X=10
X=10
X=8.5
X=8.5
X=6
X=9.5
X=11.5
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Figure B

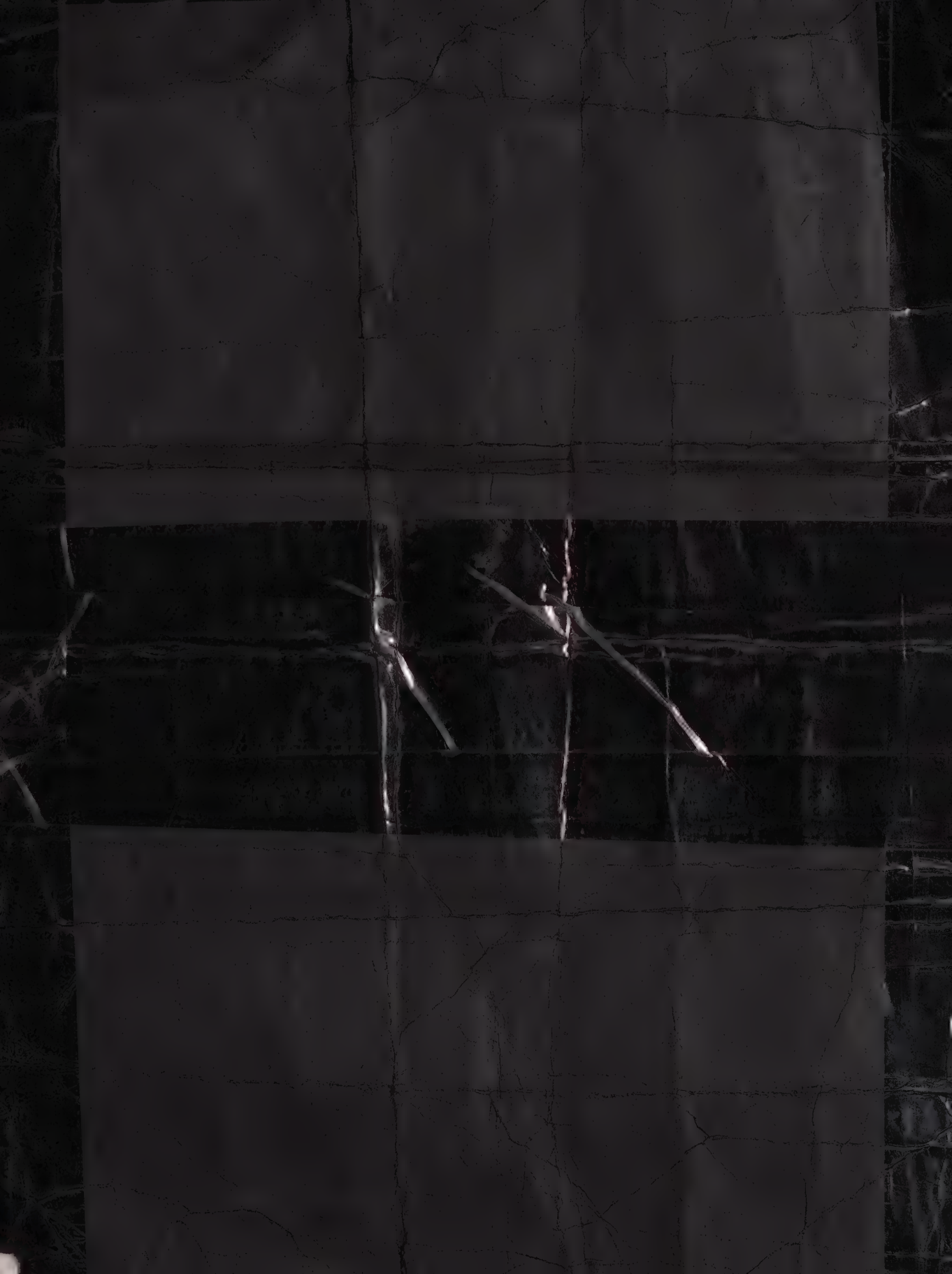
PURE TONE - AIR CONDUCTION
MASKING OPPOSITE EAR

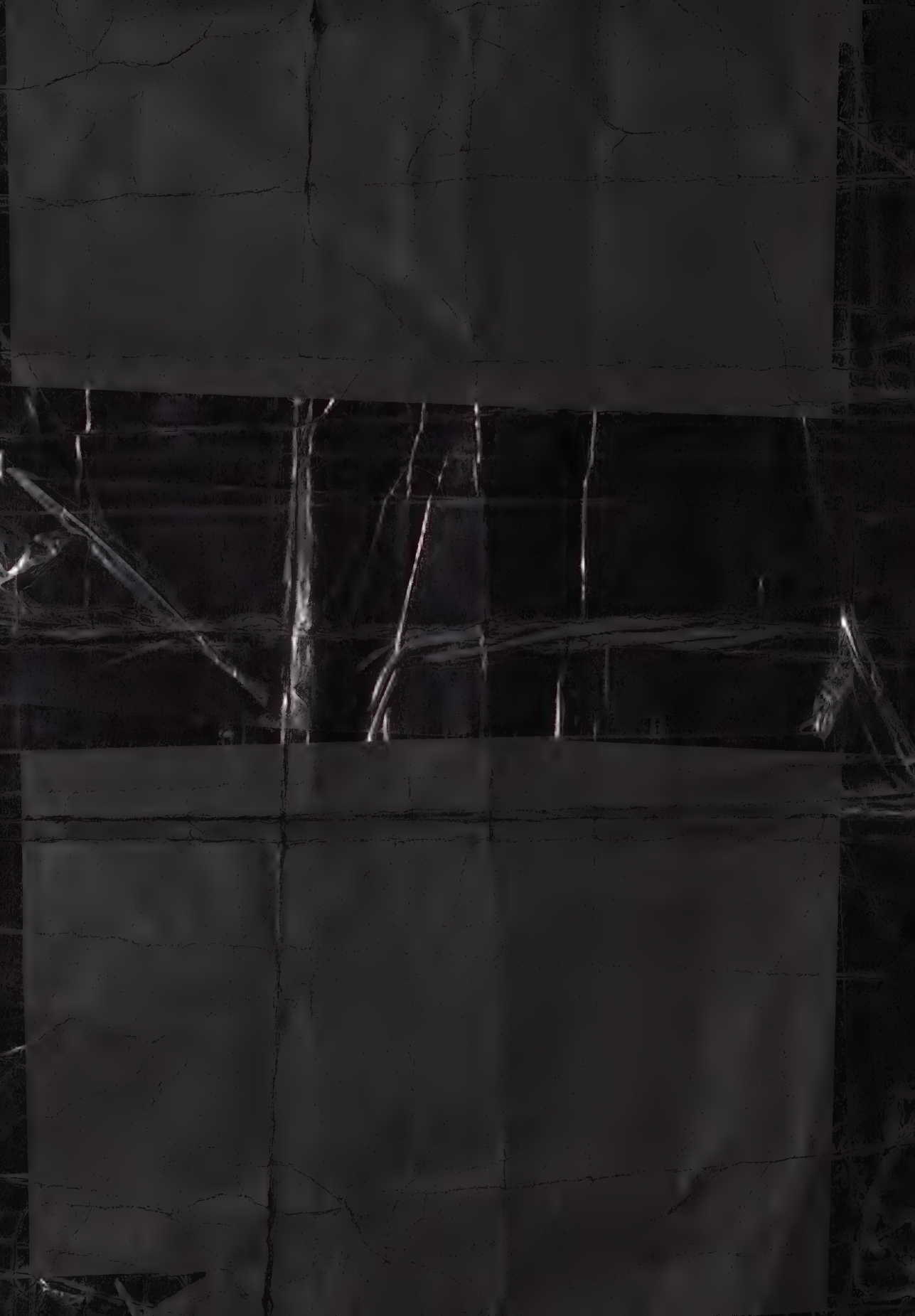
Section 5

Elimination of suspected
"shadow curve"

References:

Davis and Silverman - pp. 37, 104, 117, 319
Glorig - pp. 115, 119
Hirsh - Chapter 6
Langenbeck - pp. 99, 102
Newby, 2nd Ed. -pp. 76
Portmann and Portmann - pp. 19, 30
Sataloff - pp. 304
Zwislocki, J. J. - "Acoustical Attenuation Between the Ears," Vol. 25 JASA #4, pp.752-759, (July 1953).





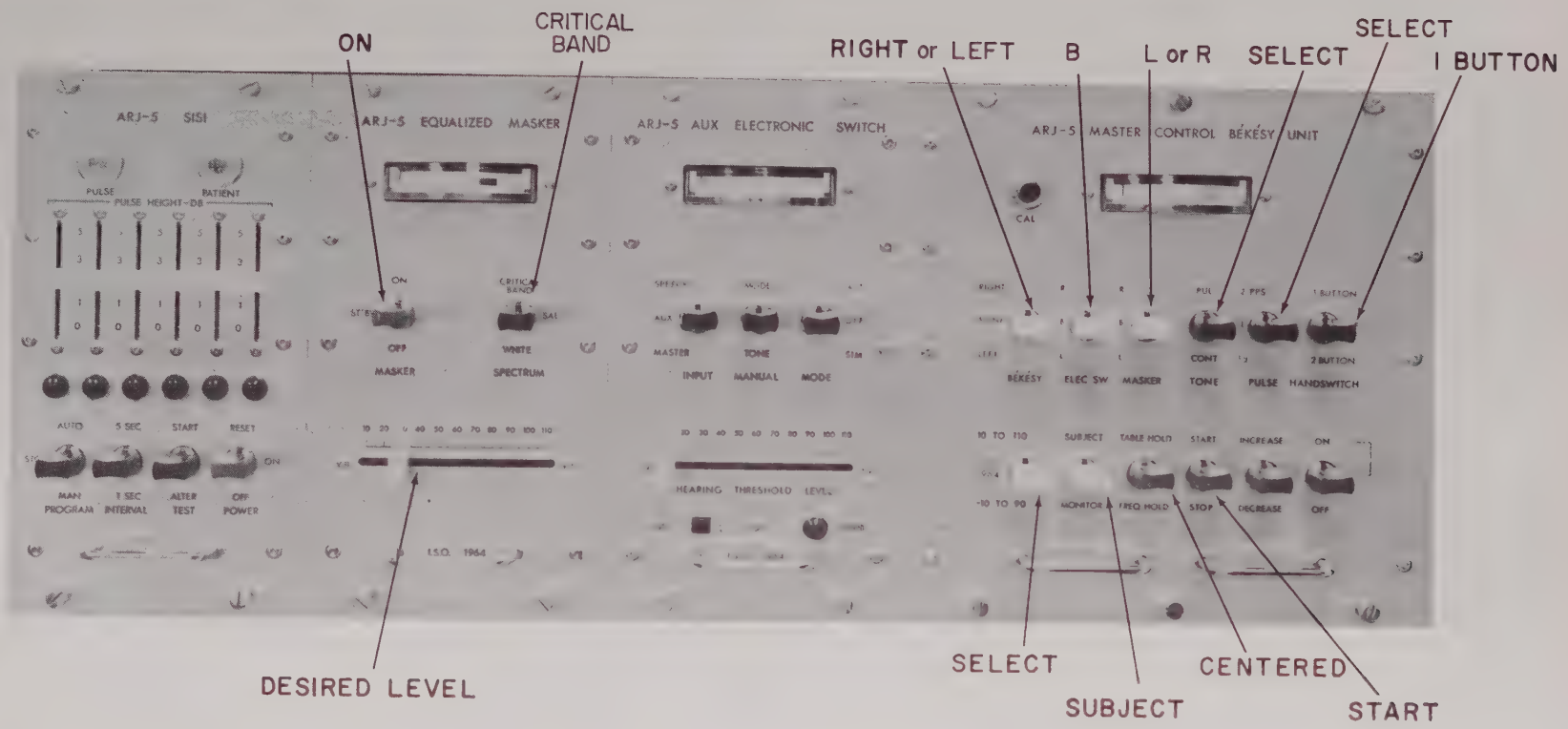


Figure 5. Pure Tone Air Conduction
Masking Opposite Ear

B6-106-129B

PURE TONE - AIR CONDUCTION
MASKING OPPOSITE EAR

Section 5

1. Set up as shown:
   A. Set table at desired frequency position.
   B. Plug one-button handswitch into Master Control Békésy 1—— H.S. (rear panel) input jack.

2. Clinical Procedure:
   A. Instruct the subject that he will hear a "tone-like" noise in one ear which he should disregard while the opposite ear is being tested.
   B. Introduce masking into better ear where there is a difference in air conduction thresholds between right and left ear of 40 dB or more. When A/C levels in both ears are 40 dB or greater, it is good audiometric practice to check the thresholds at 1000 Hz for each ear with masking in the opposite ear. This will ensure that cross-head stimulation is not yielding false thresholds. (See Section 6.)
   C. Set masking level at 60 dB if hearing levels without masking are at least 20 dB or more. Since the "cross-head" attenuation varies from about 50 dB at 500 Hz to about 60 dB at high frequencies, a setting of 60 dB of critical band masking will not produce significant masking in the contralateral ear for frequencies of 500 Hz and above. The 60 dB setting does not mean that the sound pressure level will be 60 dB, but that the noise will just mask a pure tone (in the same ear) at a hearing threshold level of 60 dB. Thus,

if cross-head attenuation for a given tone was 50 dB, then the noise would just mask a 10 dB HTL setting if the pure tone was in the opposite ear.

D. Proceed with air conduction testing as outlined in Section 4.

3. Interpretation:

When air conduction thresholds of the right and left ear differ by 40 dB or more, it is possible that the thresholds obtained for the poorer ear may be a "shadow curve" of the better ear. A "shadow curve" (or cross-hearing) is caused by transmission of the tone through the bones of the skull or around the head from the test ear to the ear not under test.

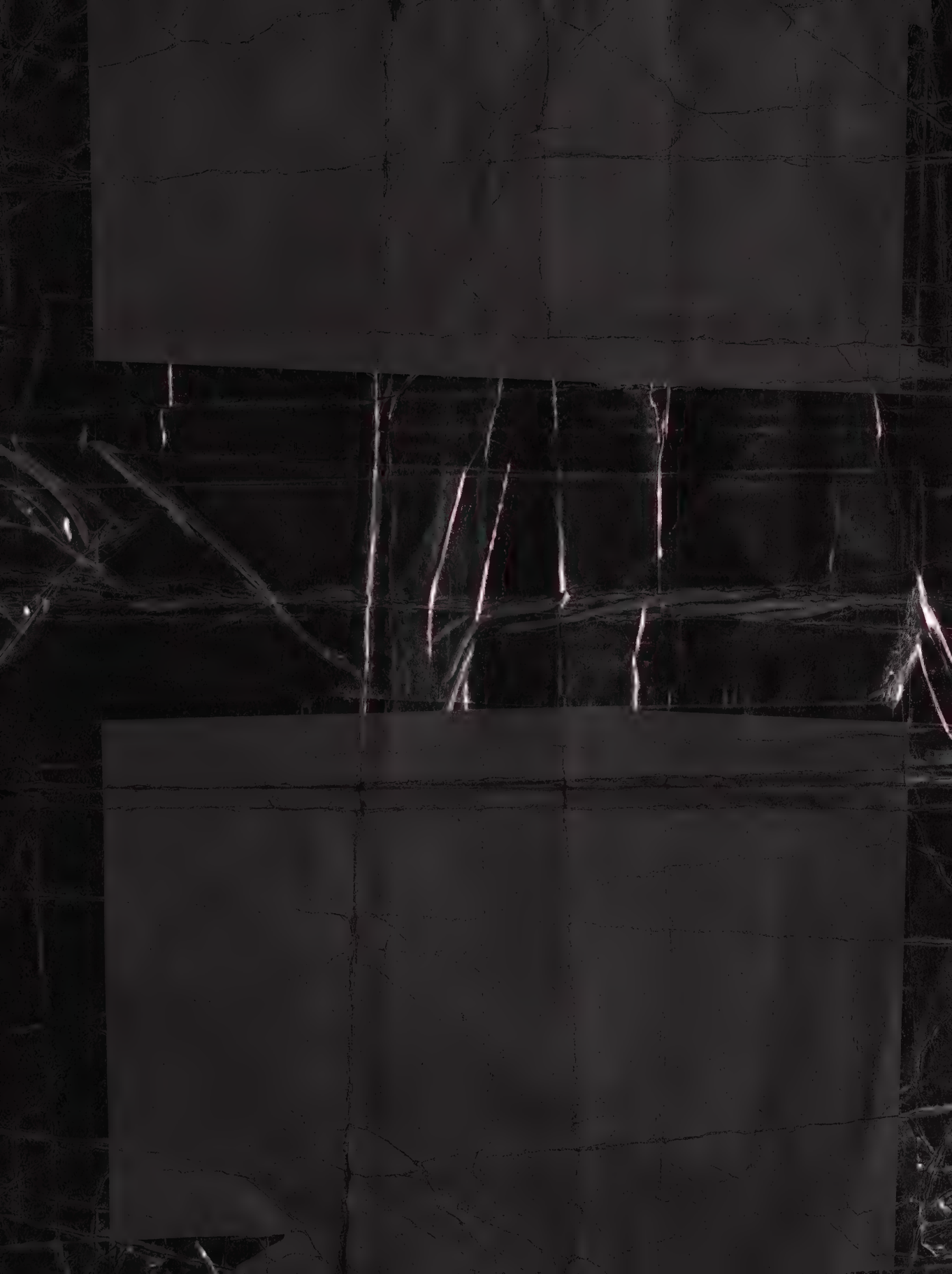
When A/C thresholds for both ears are greater than 40 dB, even though there appears to be very little difference in left and right ear thresholds without masking, cross-hearing may be responsible for the thresholds of the poorer ear. Masking should be used in the better ear to eliminate the possibility of cross-hearing.

Reviewers' Comments:

"Describe test tone to be heard in ear under test -- demonstrate if necessary."

"Mask if there is a difference of 40 dB or more between A/C thresholds of one ear and B/C thresholds of the other ear."

"The possibility of cross-over is frequency related. You should mask for as little as 25-30 dB difference between ears at the low frequency end of the scale; conversely, in the high frequencies a critical difference is not reached until 50-55 dB."



CRITICAL BAND MASKING

Section 6

May be used when high intensity
levels of masking are not desirable

References:

Newby, 2nd Ed. - pp. 246-248, 260
O'Neill & Oyer - pp. 66-68
Sataloff - pp. 307

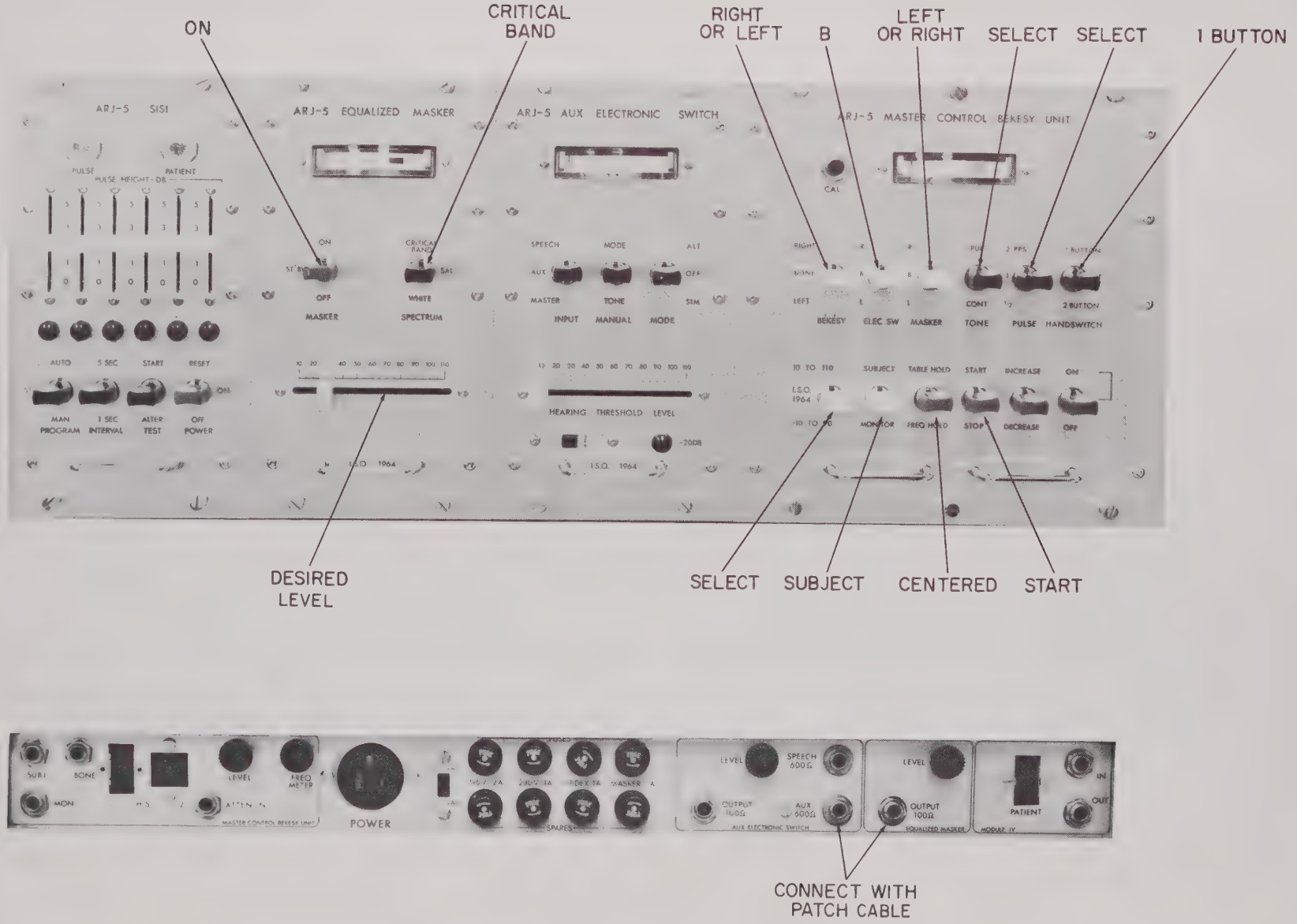


Figure 6. CRITICAL BAND MASKING

B6-106-129C

CRITICAL BAND MASKING

Section 6

1. Set up as shown:
   A. Set table at desired frequency position.
   B. Plug one-button handswitch into Master Control Békésy 1-H.S. (rear panel) input jack.
   C. Select CRITICAL BAND on the Equalized Masker SPECTRUM switch.

2. Clinical Procedure:
   A. CRITICAL BAND Masking is the most efficient form of masking noise and is recommended whenever pure tone masking is required. (See Section 1, 5.C.)
   B. Follow the Clinical Procedure outlined in Section 5 for pure tone air conduction masking.
   C. The CRITICAL BAND masker may also be used to obtain thresholds as an input to the Auxiliary Electronic Switch. Adjust the output of the Equalized Masker attenuator at 500 Hz so that the Auxiliary Electronic Switch meter shows a deflection of zero VU. Then, the HTL attenuator on the Auxiliary Electronic Switch unit will be approximately correct for all critical bands.
   D. Free field thresholds for noise bands may be measured by the procedure outlined in C. above. The use of narrow bands of noise eliminates most of the problems caused by standing waves when free field thresholds for pure tones are measured.

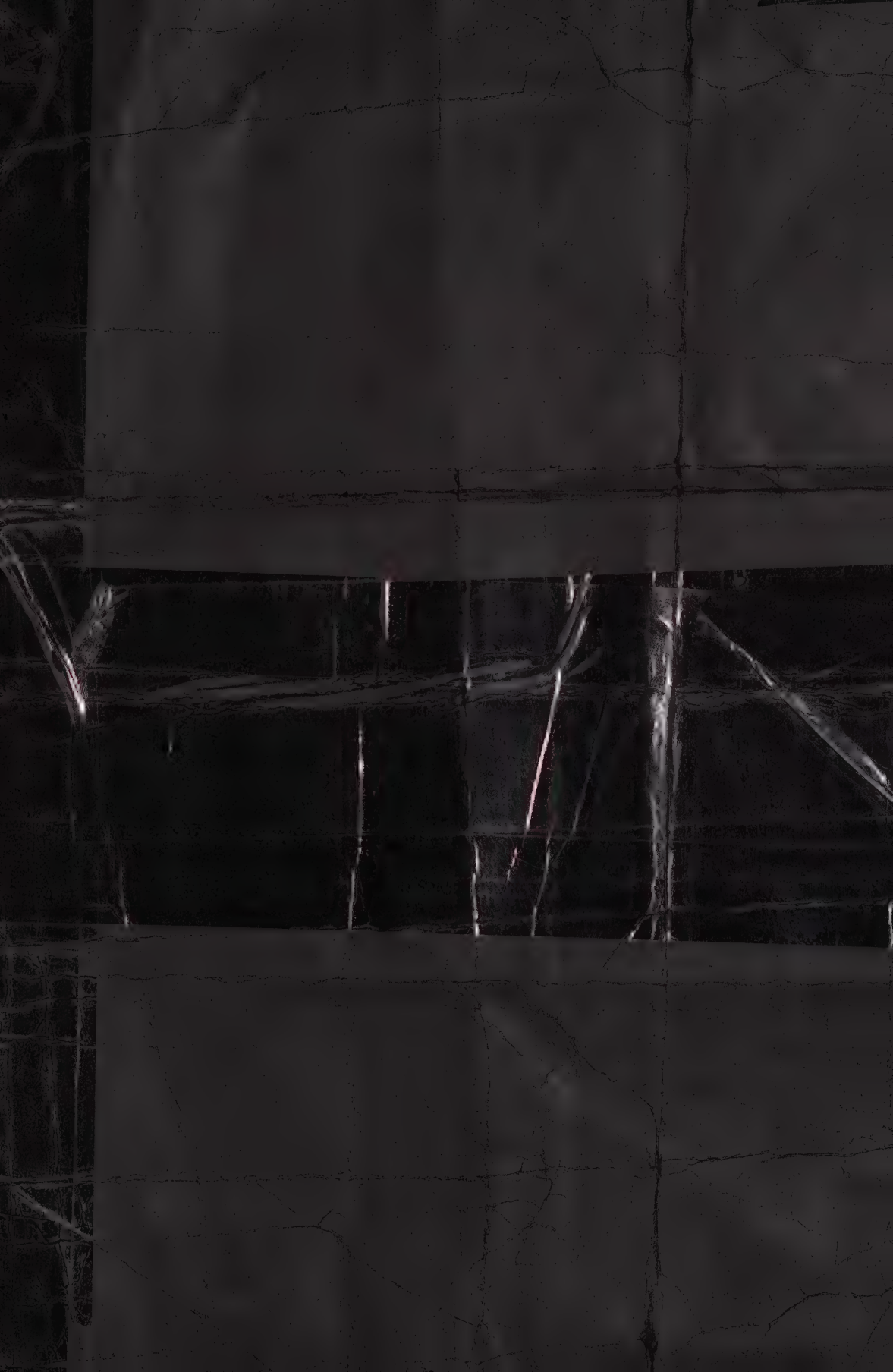
E. Hearing aid gain may be measured more effectively by the use of narrow band noise as the stimulus instead of pure tones. Narrow band noise minimizes the effects of standing waves and of sharp peaks and dips which often occur in the pure tone response of some aids. Thresholds are obtained following the procedure in D. with and without the hearing aid.

3. Interpretation:

Critical Band is the most efficient bandwidth for masking because it requires the least amount of noise energy, is most comfortable to the subject, and the level of masking is calibrated in terms of HTL settings. As the frequency changes, the bandwidth and noise level change to assure uniform HTL masking. Thus, if the attenuator is set on 60 dB and both noise and pure tone are delivered to the same ear, a person with normal hearing will show a masked threshold of 60 dB (±5 dB) for all frequencies. Using Békésy techniques, it is extremely simple to check for overmasking by altering the masking level and noting any immediate changes in the threshold levels.

Reviewers' Comments:

None.



BONE CONDUCTION - NO MASKING

Section 7

Determination of type of loss

References:

Davis & Silverman - pp. 76, 87, 177

Glorig - pp. 119-122

Langenbeck - pp. 20-23

Newby (1948) - pp. 80-85

Newby, 2nd Ed. - pp. 78-84

O'Neill & Oyer - pp. 66-68, 71-75

Portmann & Portmann - pp. 8-16

Sataloff - pp. 305-313

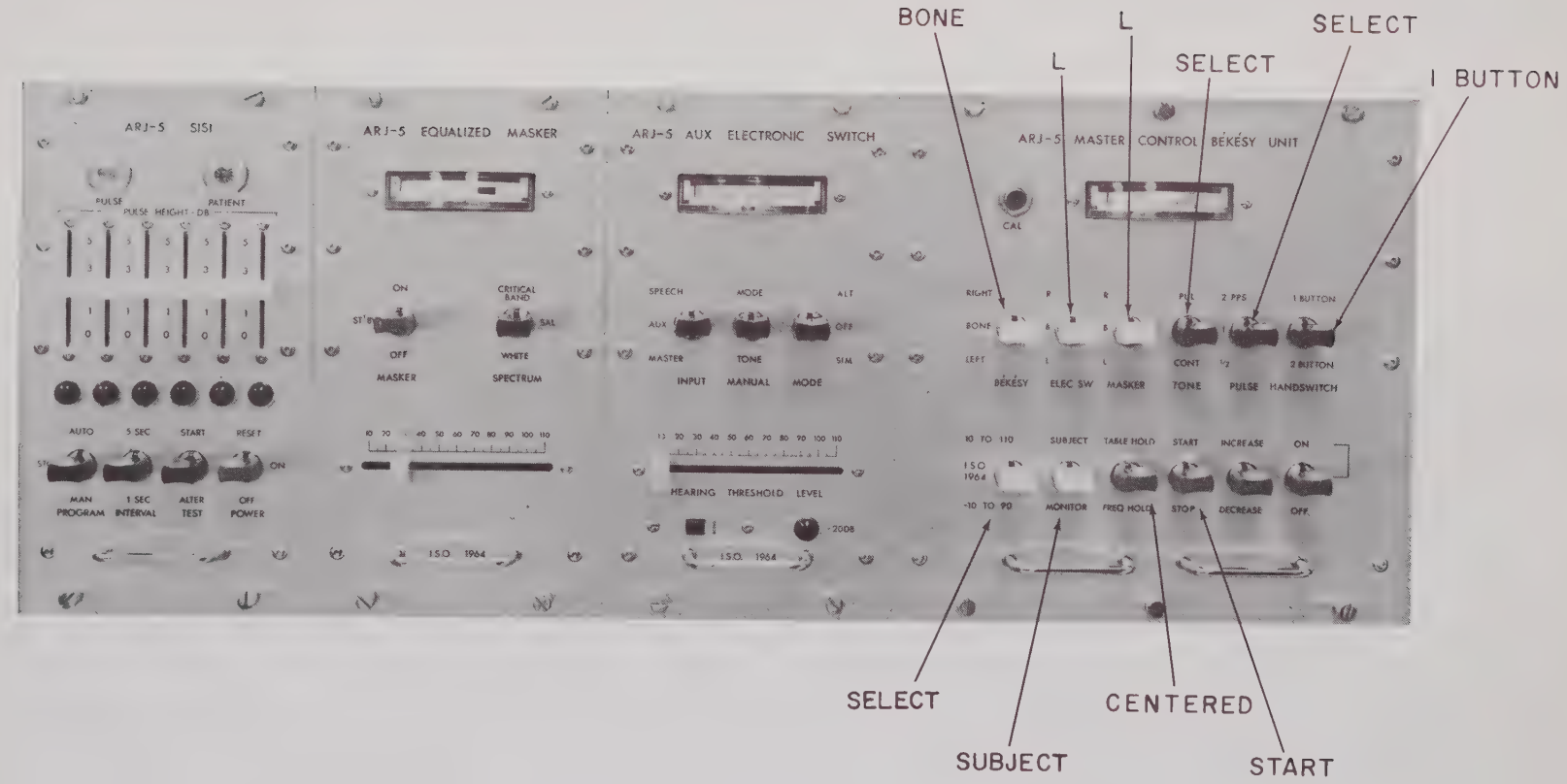


Figure 7. Bone Conduction, No Masking

B6-106-131 A

BONE CONDUCTION - NO MASKING

Section 7

1. Set up as shown:

   A. Set table at desired frequency position.

   B. Plug one button handswitch into Master Control Békésy 1 —— H.S. (rear panel) input jack.

   C. Plug bone vibrator into Master Control Békésy BONE (rear panel) input jack.

   D. Observe test, if subject allows stylus to go beyond 40 dB activate INCREASE/DECREASE switch to DECREASE to run well below 40 dB before returning control to subject.

   E. When 4000 Hz frequency is completed, depress START/STOP switch to STOP position.

2. Clinical Procedure:

A. Some clinicians feel masking should always be administered to the opposite ear in bone conduction testing. One method of determining the need for masking is the administration of the automatic Weber test by the following procedure:

1. Place the bone vibrator on the midline of the forehead and gradually increase the intensity of the tone until the subject reports that he can just barely hear it.
2. Increase the intensity by 20 dB and ask the subject whether he hears the tone in one ear or the other, or if it is equally loud in both ears. If the tone lateralizes to one ear, that ear should be masked while the opposite ear is tested by bone conduction.
3. If the subject reports equal loudness in both ears, it is generally safe to proceed with the bone conduction test without masking. The Weber test must be administered at each of the frequencies to be tested by bone conduction.

B. Place the bone vibrator carefully so that it is making solid contact with the mastoid bone. Avoid having the vibrator touch the pinna. Best placement can be determined by increasing the intensity to an easily perceived level, and asking the subject to move the vibrator around until he locates the place where the tone seems loudest.

C. Since masking is not employed, do not cover the opposite ear with an air-conduction receiver. Both ears should be uncovered to avoid an occlusion effect which will distort test results.

D. Follow the same procedure of testing as outlined in Section 4. After testing one ear, move the bone vibrator to the opposite mastoid and repeat the test procedure. NOTE: Bone conduction testing may be performed only on frequencies

of 250 Hz through 4000 Hz. The maximum intensity output for bone conduction testing is 40 dB unless the Range switch is in the 10 to 110 dB position, in which case the maximum intensity output is 40 dB for 250 Hz and 60 dB for 500 - 4000 Hz. In the 10 to 110 dB position, values are read on the right side of the audiogram card.

E. For another method of bone conduction testing, see the SAL test, Section 9.

3. Interpretation:

The purpose of bone conduction testing is to determine if a hearing loss is due to conductive or sensorineural factors, or a combination of the two. If the bone conduction thresholds are essentially normal when compared with abnormal air conduction thresholds, the loss is a conductive one. If abnormal bone conduction thresholds are equal to those obtained by air conduction testing, the loss is sensorineural. If there is some loss by bone, but more by air, the loss is of the mixed type. Theoretically it is not possible to have greater loss by bone than by air, although sometimes such measures occur as an artifact of the testing procedure.

Reviewers' Comments:

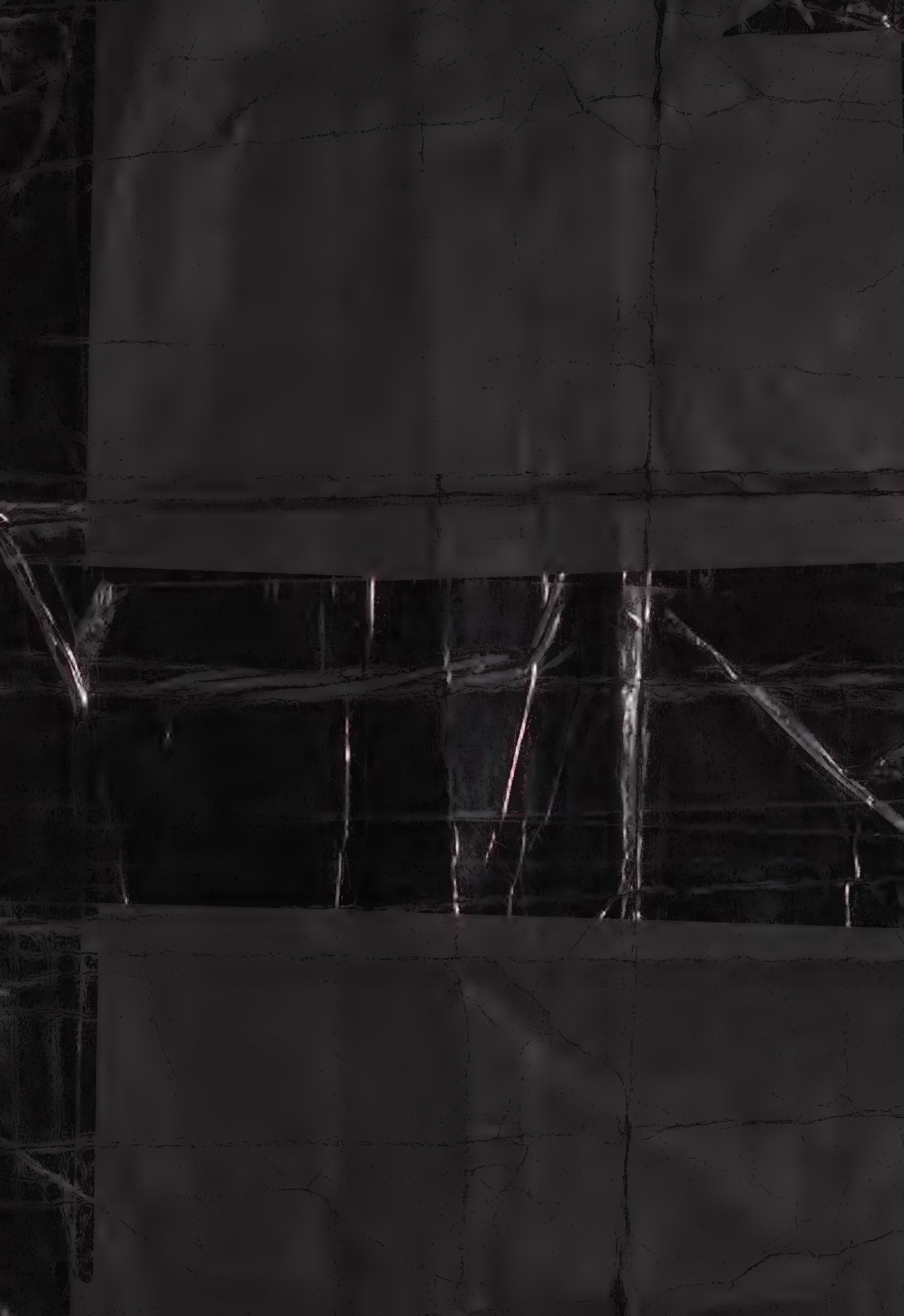
"I disagree with the overall concept of the Weber test."

"Normal hearing subjects will demonstrate nearly equal air and bone conduction thresholds at some level within normal limits of audiometric zero."

"For bone conduction losses in excess of 60 dB, the SAL test may be used."

"The Weber test is outdated."

"Be sure to caution subject to respond only to tones rather than vibrations."



BONE CONDUCTION WITH MASKING

Section 8

Elimination of suspected
"shadow curve" or "cross hearing"

References:

Davis & Silverman - pp. 177
Glorig - pp. 122-124
Hirsh - Chapter 6
Langenbeck - pp. 99-102
Newby, 2nd Ed. - pp. 76
Portmann & Portmann - pp. 19-30
Sataloff - pp. 304-313

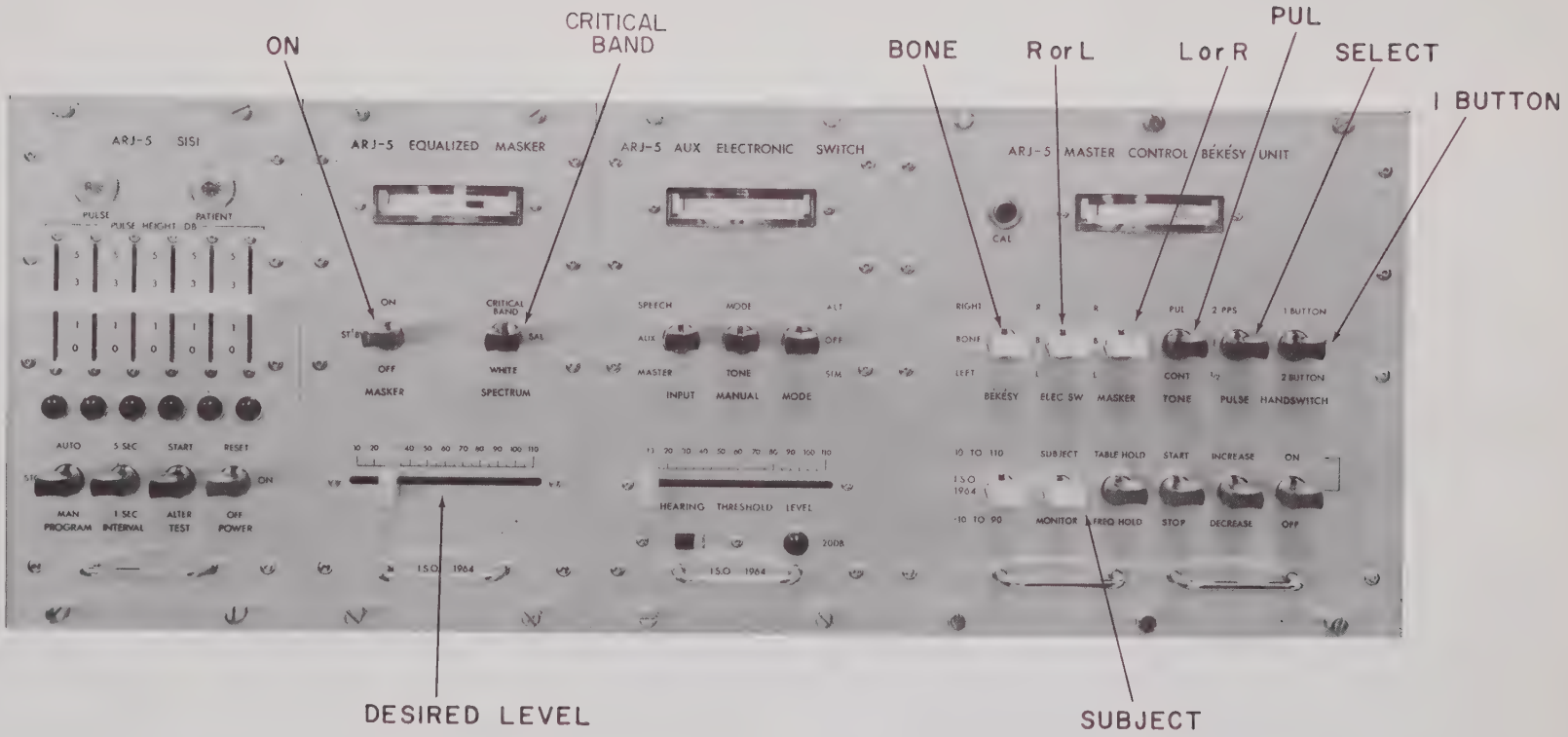


Figure 8. Bone Conduction With Masking

B6-106-131 C

BONE CONDUCTION WITH MASKING

Section 8

1. Set up as shown:

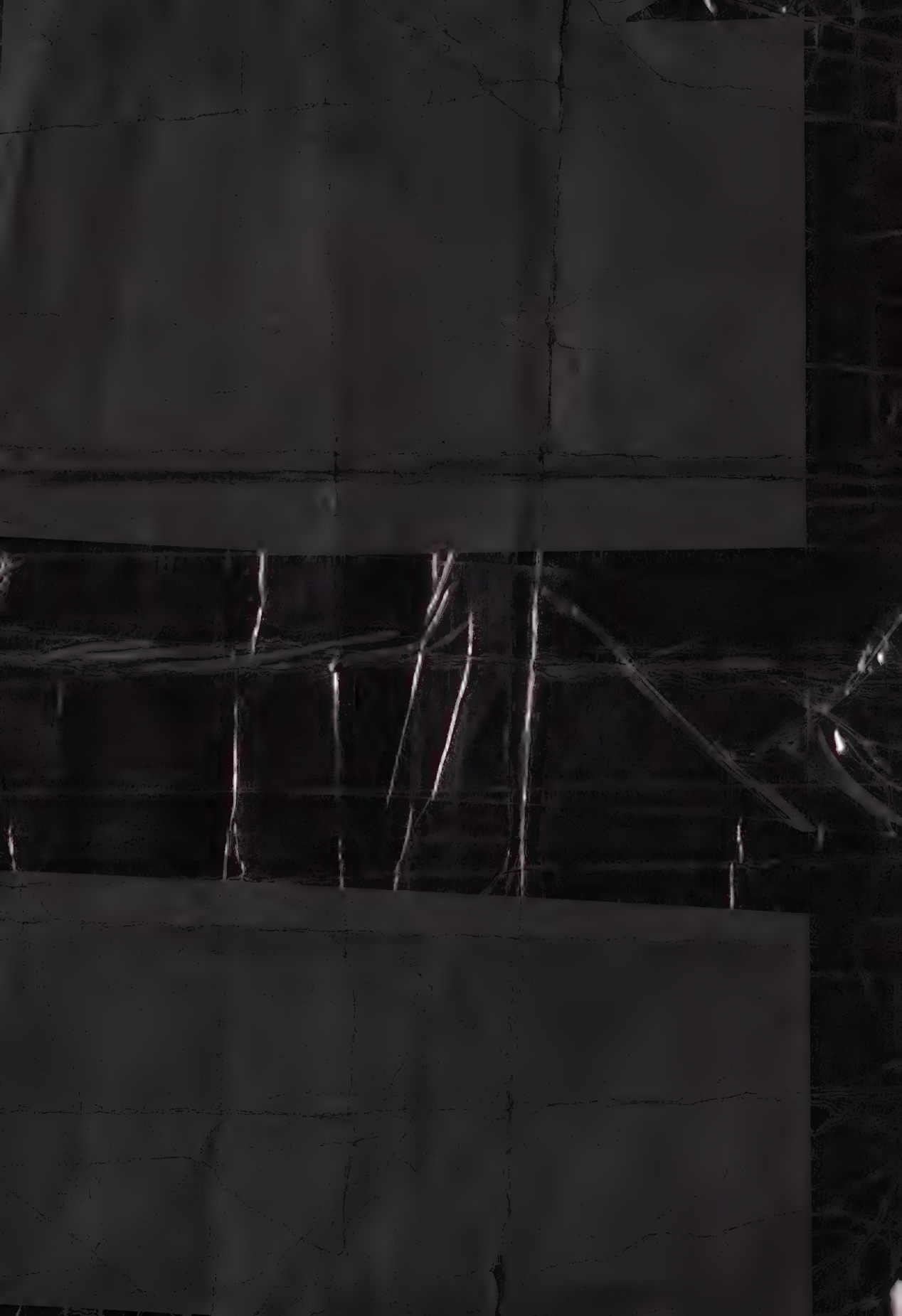
   A. Set table at desired frequency position.

   B. Plug one button handswitch into Master Control Békésy 1 —— H.S. (rear panel) input jack.

   C. Plug bone vibrator into Master Control Békésy BONE (rear panel) input jack.

   D. Set Equalized Masker attenuator to desired level.

   E. Monitor test by Master Control Békésy meter as each new frequency begins, and, if masking output adjustment is necessary, move Equalized Masker attenuator to appropriate masking level by noting A/C loss.



2. Clinical Procedure:

A. Place the masking earphone on the ear opposite the test ear. Place the earphone on the test side on the cheekbone or the side of the head, making sure it does not occlude the test ear in any way or collapse the canal by pressure. Never cover the ear under test. Place the bone vibrator on the mastoid of the ear under test, being careful not to contact the earphone or the pinna. The level of masking required may be determined by the following method.

1. Select a level of masking and proceed to obtain bone conduction thresholds of the ear under test while that level of masking is applied to the opposite ear.
2. Increase the level of the masking noise by 10 dB and obtain thresholds again. If thresholds are the same as in step A 1 the level of masking noise probably is sufficient. A further check should be made by raising masking level by 10 dB again and obtaining thresholds.
3. If threshold obtained in step A 2 is 10 dB greater than threshold obtained in step A 1, there may be two explanations: (a) the ear under test was insufficiently masked in step A 1, or (b) the increase in the level of the masking noise (step A 2) caused an interference with the ear under test.
4. To determine which explanation is correct, continue increasing the level of the masking noise and obtaining thresholds at each 10 dB increase in masking. If the thresholds in the ear under test increase proportionately with the increase in masking level, masking is too intense at the point where the thresholds began to increase in proportion to level of masking.

5. When the correct level of masking is obtained, bone conduction thresholds will not be affected by an increase or decrease of 10 dB in the masking signal.
6. Even though a question of masking may or may not remain, it is recommended that the SAL Test be performed to provide additional information.

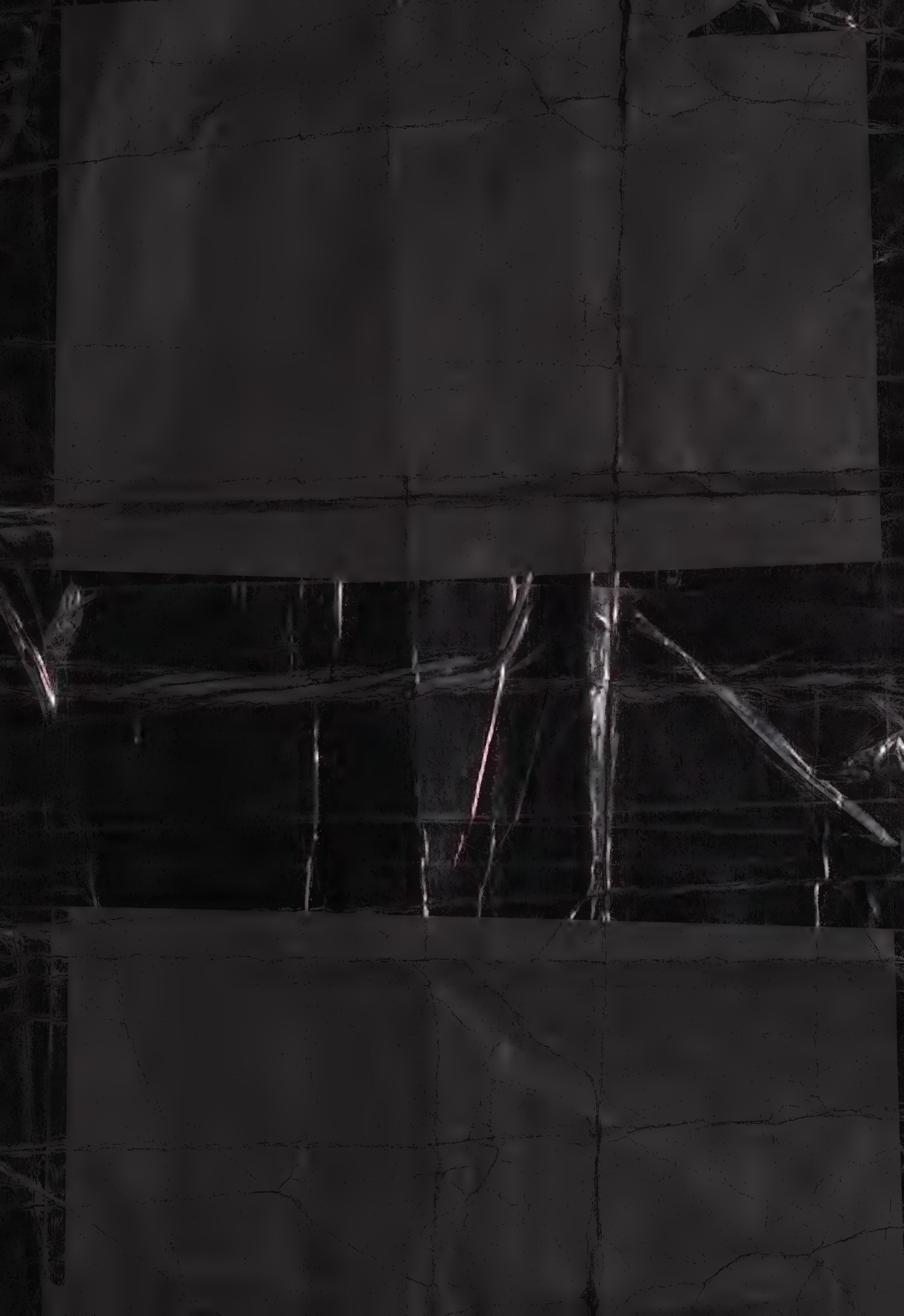
3. Interpretation:

The purpose of bone conduction testing is to determine if a hearing loss is due to conductive or sensorineural factors, or a combination of the two. If the bone conduction thresholds are essentially normal, the loss is a conductive one. If abnormal bone conduction thresholds are equal to those obtained by air conduction testing, the loss is sensorineural. If there is some loss by bone, but more by air, the loss is of the mixed type. Theoretically it is not possible to have greater loss by bone than by air, although clinically sometimes such measures occur as an artifact of the testing procedure.

Reviewers' Comments:

"I disagree with the masking technique advocated."

"If a greater loss exists by bone conduction than by air conduction, the difference could be due to a calibration error, noise in the test area, or improper positioning of the transducer."



SAL TEST

Section 9

Eliminates concern about lateralization of masking noise or test signal and pure tone calibration of the bone conduction oscillator.

References:

Glorig - pp. 125

Jerger, J. F., and Tillman, T. "A New Method for the Clinical Determination Sensorineural Acuity Level (S.A.L.)," Arch. Otolaryng., 71:948, 1960.

Newby, 2nd Ed. - pp. 82-84

O'Neill & Oyer - pp. 68-71

Simon, G. R., "The Sensorineural Acuity Level (SAL) Technique with Narrow-band Noise", Journal of Aud. Res., 4: 191-194, 1964.

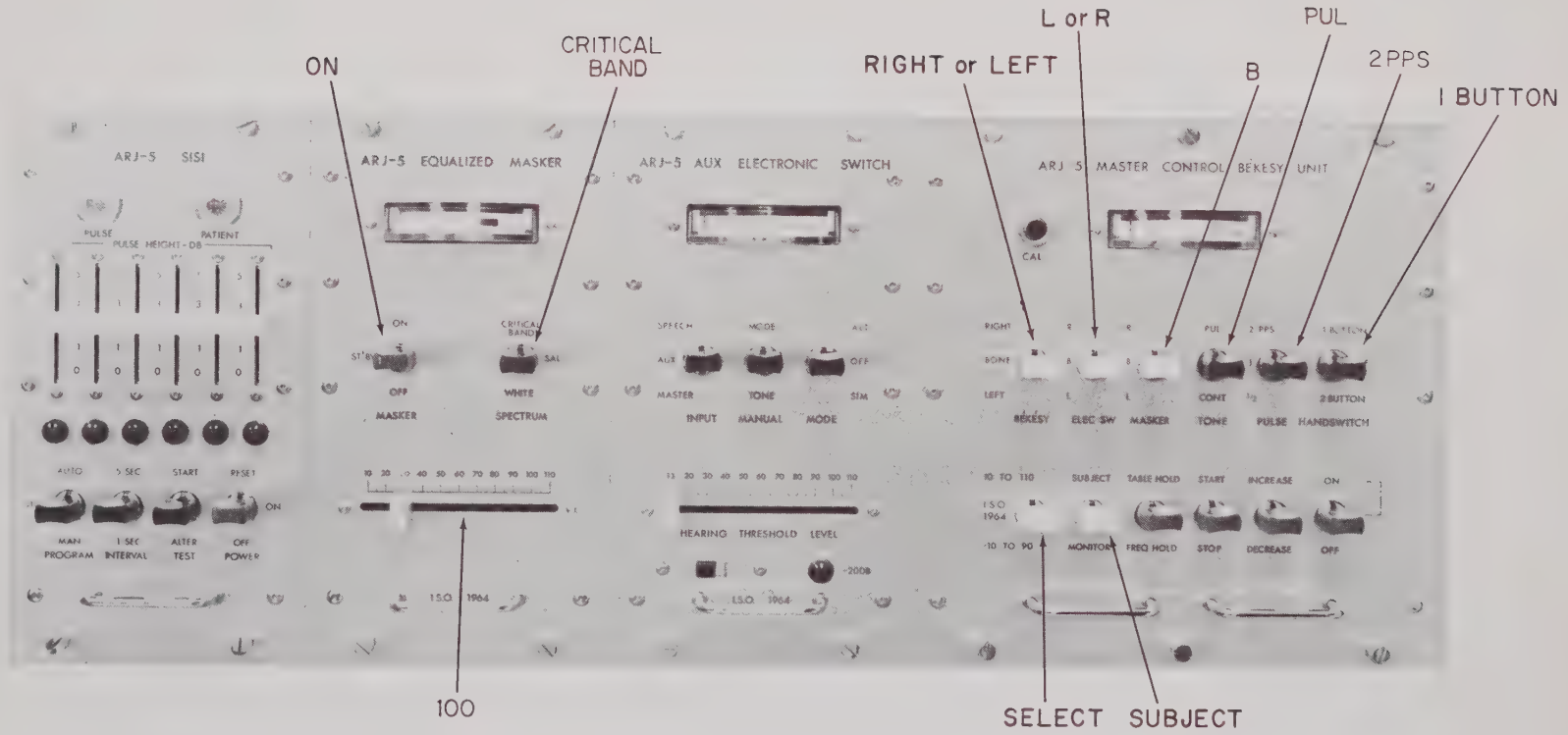


Figure 9. SAL Test

B6-106-126 A

SAL TEST

Sensorineural Acuity Level

Section 9

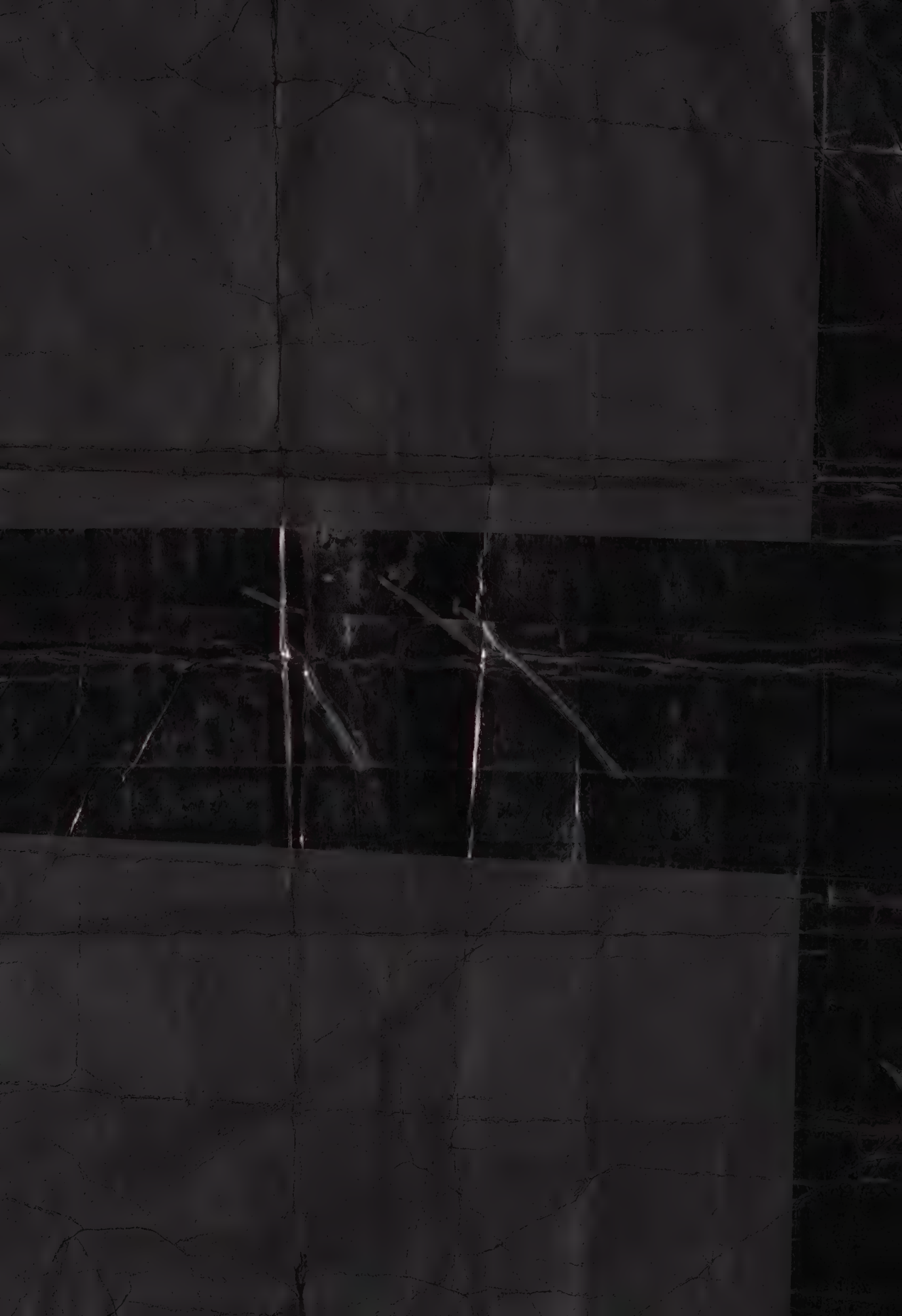
1. Set up as shown:

   A. Set table at desired frequency position.

   B. Plug bone vibrator into Master Control Békésy BONE (rear panel) input jack.

   C. Plug one button handswitch into Master Control Békésy 1 —— H.S. (rear panel) input jack.

   D. Be sure to mechanically isolate the vibrator headband from the earphone headband. Soft sponge rubber placed between the two headbands is usually sufficient.



2. Clinical Procedure:
   A. The bone conduction vibrator is applied to the middle of the forehead.
      1. After obtaining air conduction thresholds in the normal manner, introduce CRITICAL BAND noise to the bone vibrator on the forehead and obtain masked air conduction thresholds.
      2. Compute the threshold shift produced by the noise at each frequency and subtract this figure from the normal shift at that frequency determined in 5 to 10 normal hearing subjects. Approximate normal shift for five frequencies is given below. However, it is wise to establish norms for each audiometer. The difference between normal shift and obtained shift will be the sensorineural hearing loss in decibels.

NORMAL SHIFT IN DECIBELS

Frequency (Hz)	250	500	1,000	2,000	4,000
dB	20	40	60	60	60

      3. If no shifts are observed, rerun masked thresholds with masker attenuator at 110 dB. At this setting, the threshold shifts should be 10 dB greater than those listed in the table.

3. Interpretation:
   A. This method eliminates the problem of whether or not to mask and how much masking to use on the non-test ear. As with the RAINVILLE, this procedure is not affected by cross-hearing of the noise.

B. Subjects with sensorineural hearing loss will not be influenced by the bone conducted masking noise, and will show only slight threshold shift under conditions of the SAL test as compared to normal hearing subjects.

C. Normal hearing subjects and subjects with essentially conductive losses will be affected by the bone conducted masking noise of the SAL test, and demonstrate air conduction threshold shifts in agreement with the established normal shifts.

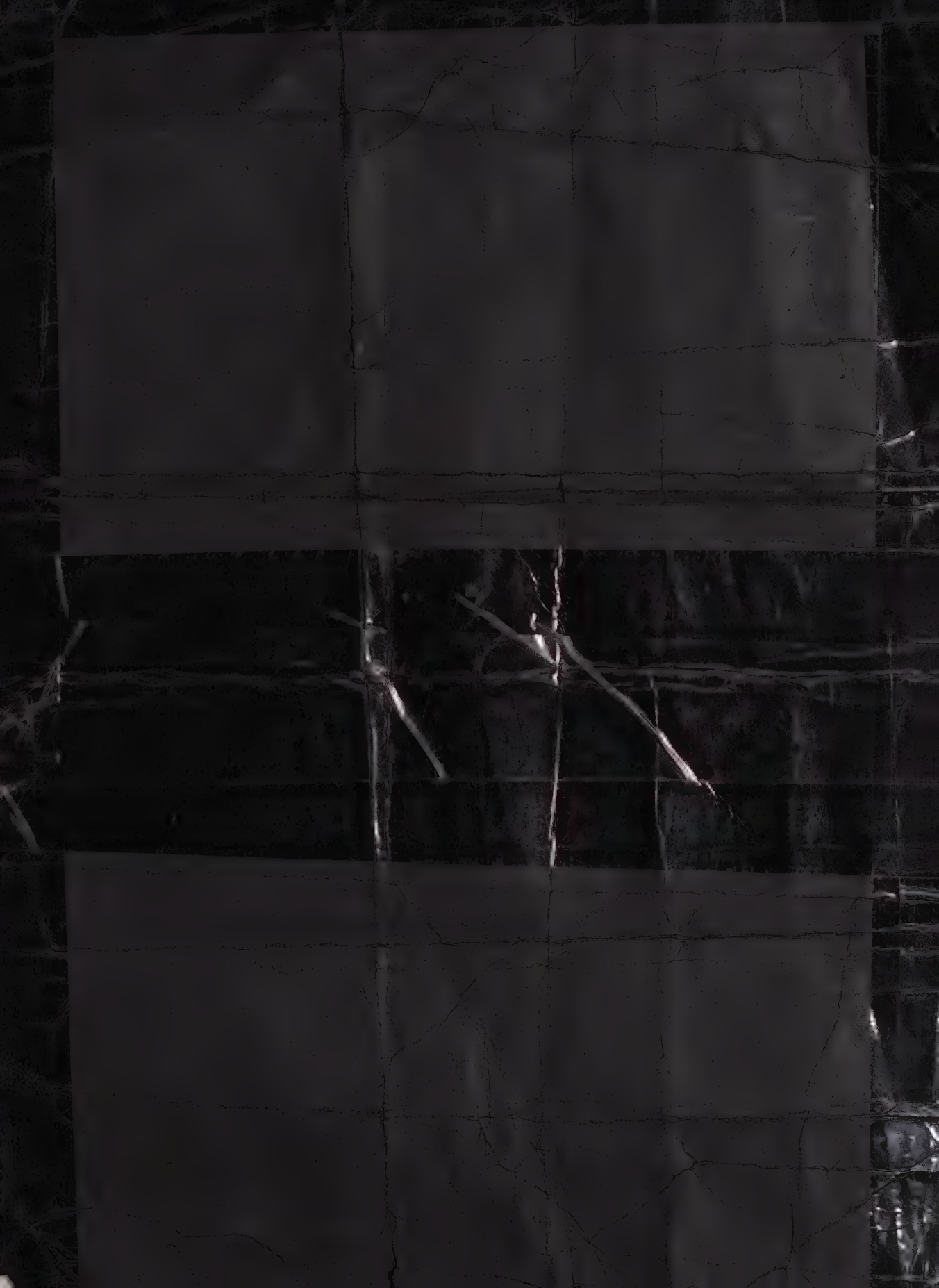
D. As one gains experience in looking at the Békésy audiograms with and without masking noise, the need to obtain a bone conduction threshold will disappear. What is really important is whether or not the noise causes a significant change in thresholds. If there is no gap between the unmasked and the masked curves, the losses are all inner ear losses. If the gap is large, as for normal ears, then the unmasked losses are middle ear losses. The degree of middle ear loss is measured by the lack of a "normal gap" between the two curves.

Reviewers' Comments:

"This test poses many problems, such as: occlusion effect, differences between conductive and sensorineural losses, etc."

"Greater normal shifts at 250 Hz may be obtained by increasing masking level at this frequency to establish norms."

"It is possible for the subjects to experience increased sensitivity at low frequencies due to the occlusion effect."



RAINVILLE TEST

Section 10

Eliminates concern about contralateralization
of masking noise

References:

Glorig - pp. 125
Newby, 2nd Ed. - pp. 82-84
O'Neill & Oyer - pp. 68-71
Rainville, M. J. New Method for the Determination of Bone Conduction Curves
Translations of the Beltone Institute for Hearing Research, No. 11, 1959
Sataloff - pp. 309

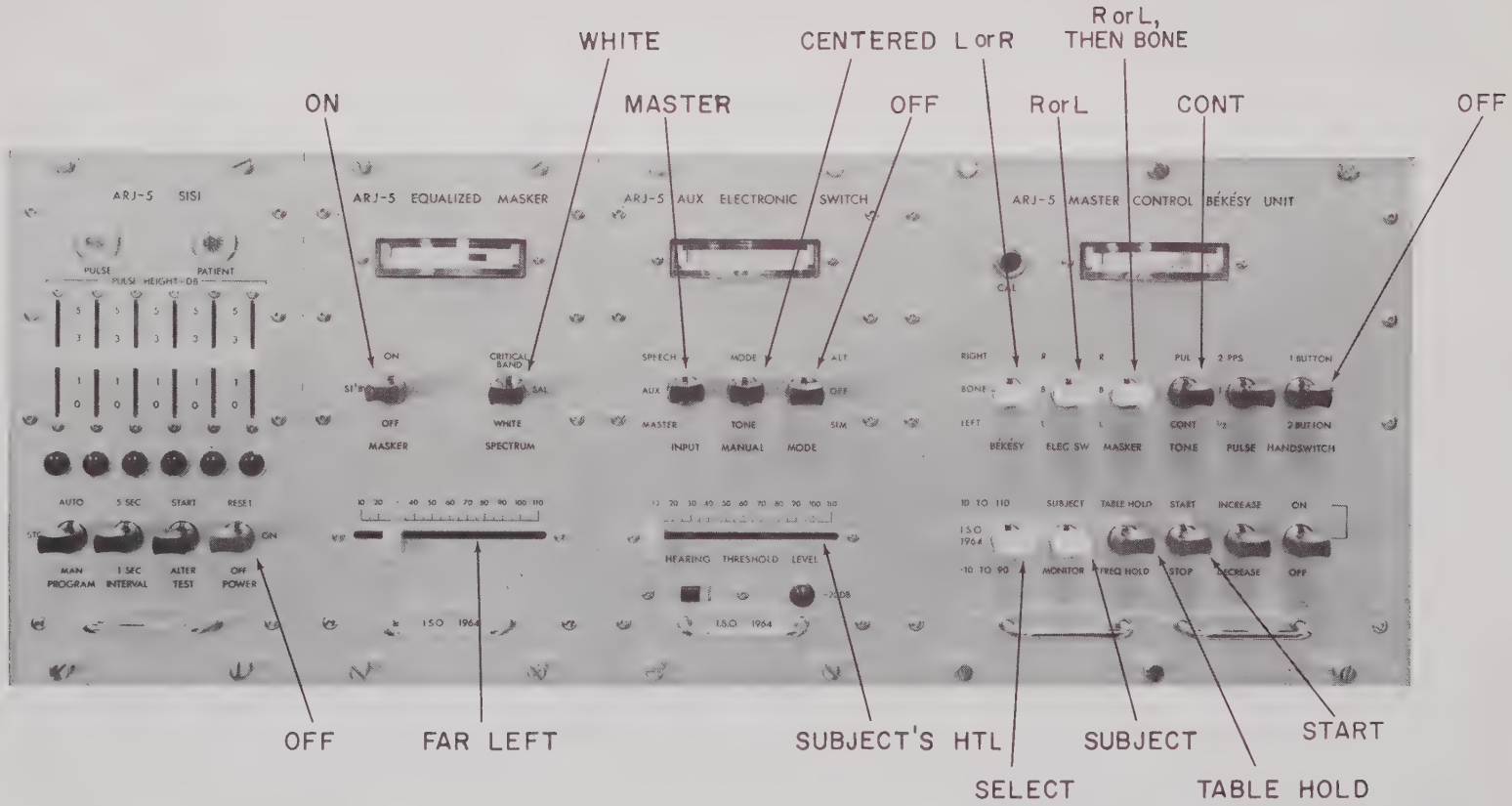


Figure 10. Rainville Test

B6-106-131 B

RAINVILLE TEST

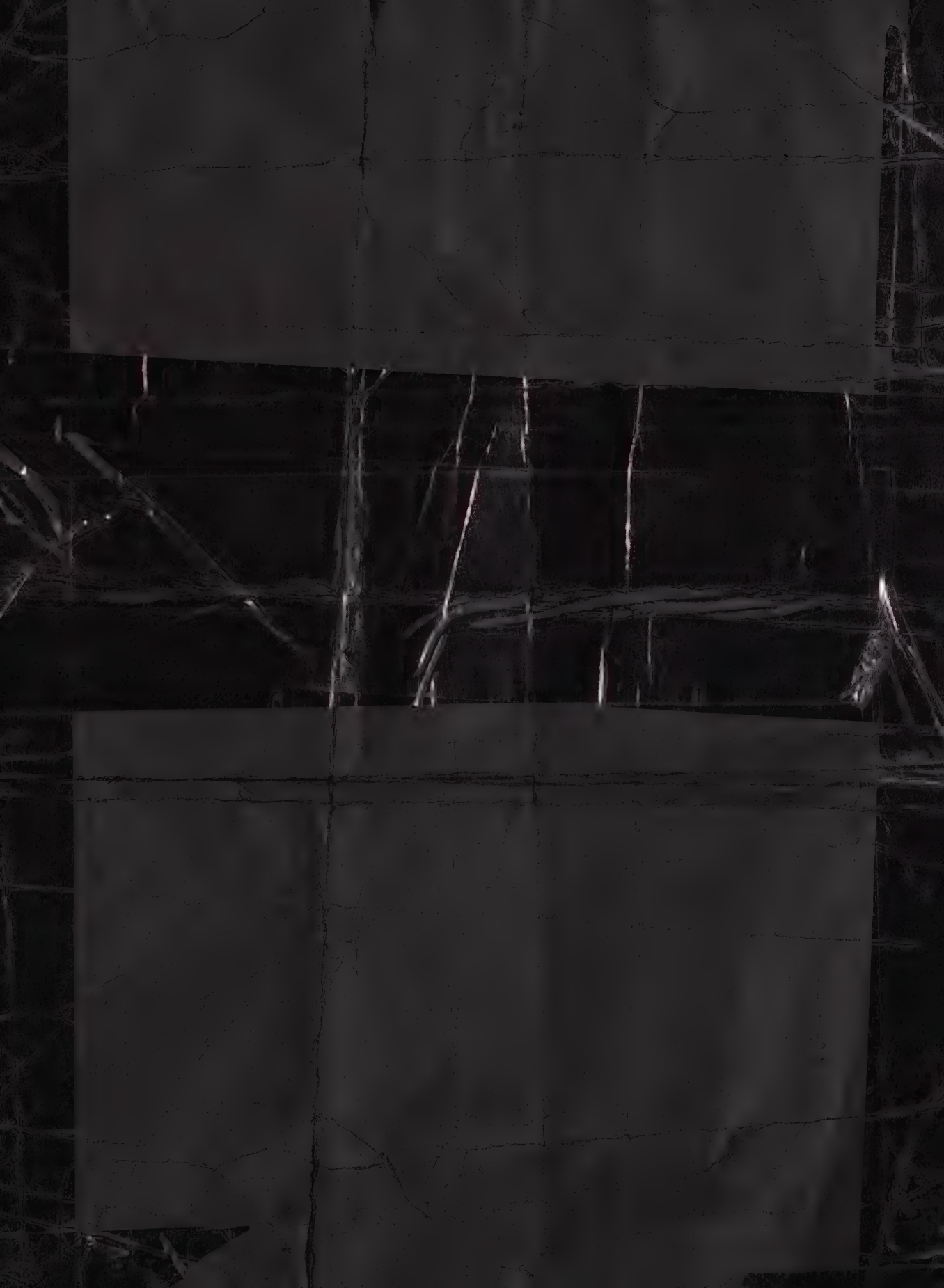
Section 10

1. Set up as shown:

   A. Set table at desired frequency position.

   B. Plug bone vibrator into Master Control Békésy BONE (rear panel) input jack.

   C. Set Auxiliary Electronic Switch HEARING THRESHOLD LEVEL on subject's threshold for the test frequency.

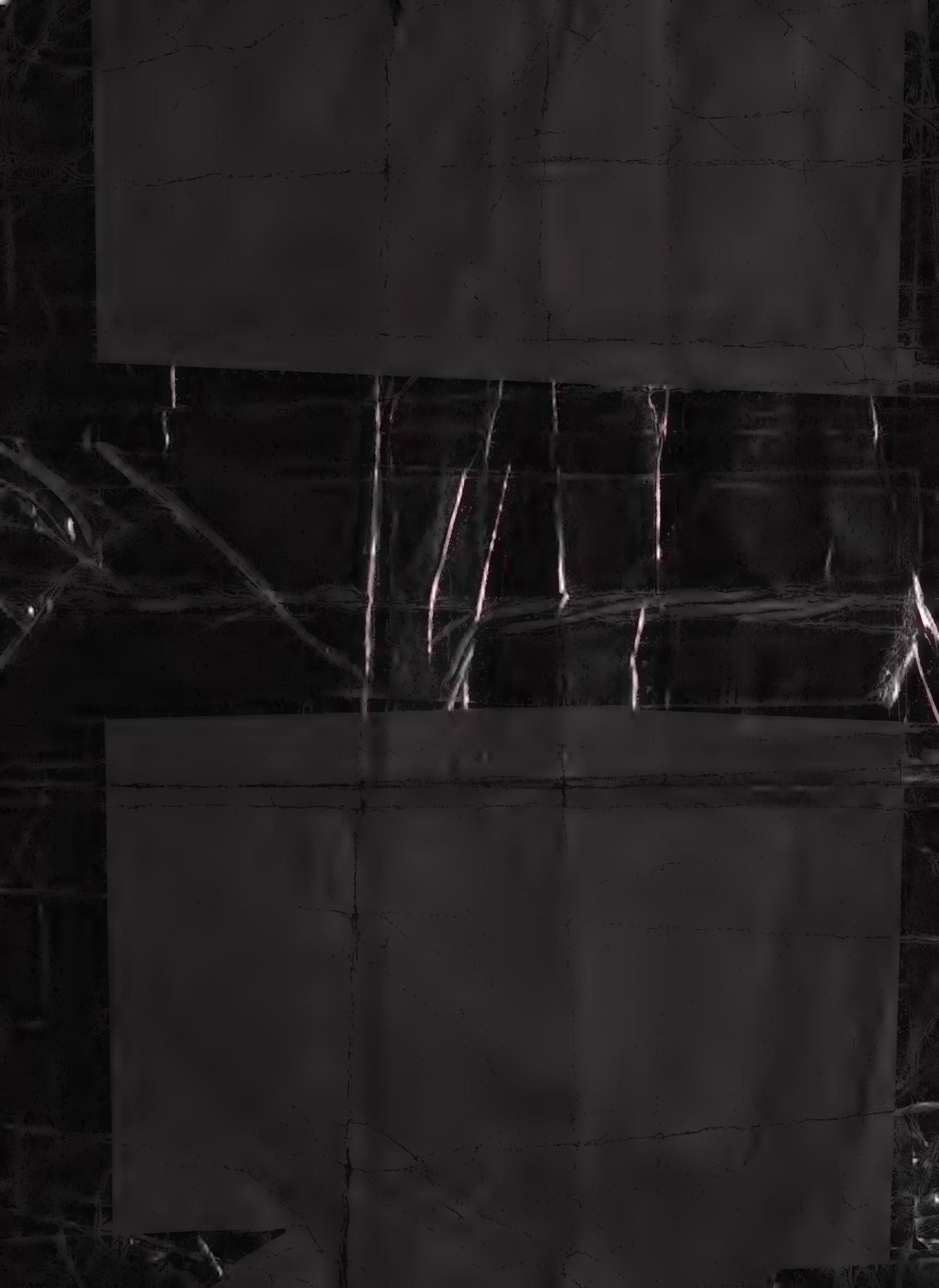


2. Clinical Procedure:
   A. The bone conduction vibrator is applied to the mastoid of the ear being tested. Be careful when placing the vibrator that it does not touch the pinna or the earphone.
      1. Determine the air conduction threshold (act) in the regular manner.
      2. While presenting the tone at this threshold, introduce a continuous noise (via air conduction) to the test ear, and increase the intensity until the tone is masked. Call this level the intensity of necessary noise (acn).
      3. Continue presenting the tone at threshold level, and turn off the noise.
      4. Introduce white noise through the bone conduction vibrator until the tone is masked. Call this the bone conduction intensity of necessary noise (bcn).
      5. The threshold of Absolute Bone Conduction (ABC) for a given frequency would be: ABC = bcn-(acn-act).

3. Interpretation:
   A. In masking a cochlea during conventional bone conduction techniques, the noise may be conducted to the contralateral cochlea. Following this procedure, however, this cross-hearing of the noise is of no importance. That is, cross-hearing of the noise does not affect measurements obtained by the Rainville procedure.

Reviewers' Comments:

None



SPEECH TESTING

Section 11

SRT by spondees, SRT by running speech,
MCL, UCL, DYNAMIC RANGE, DISCRIMINATION

References:

Davis & Silverman - pp. 189-198
Glorig - Chapter 7
Hirsh - Chapter 5
Newby (1958) - Chapter 6
Newby, 2nd Ed. - Chapter 6

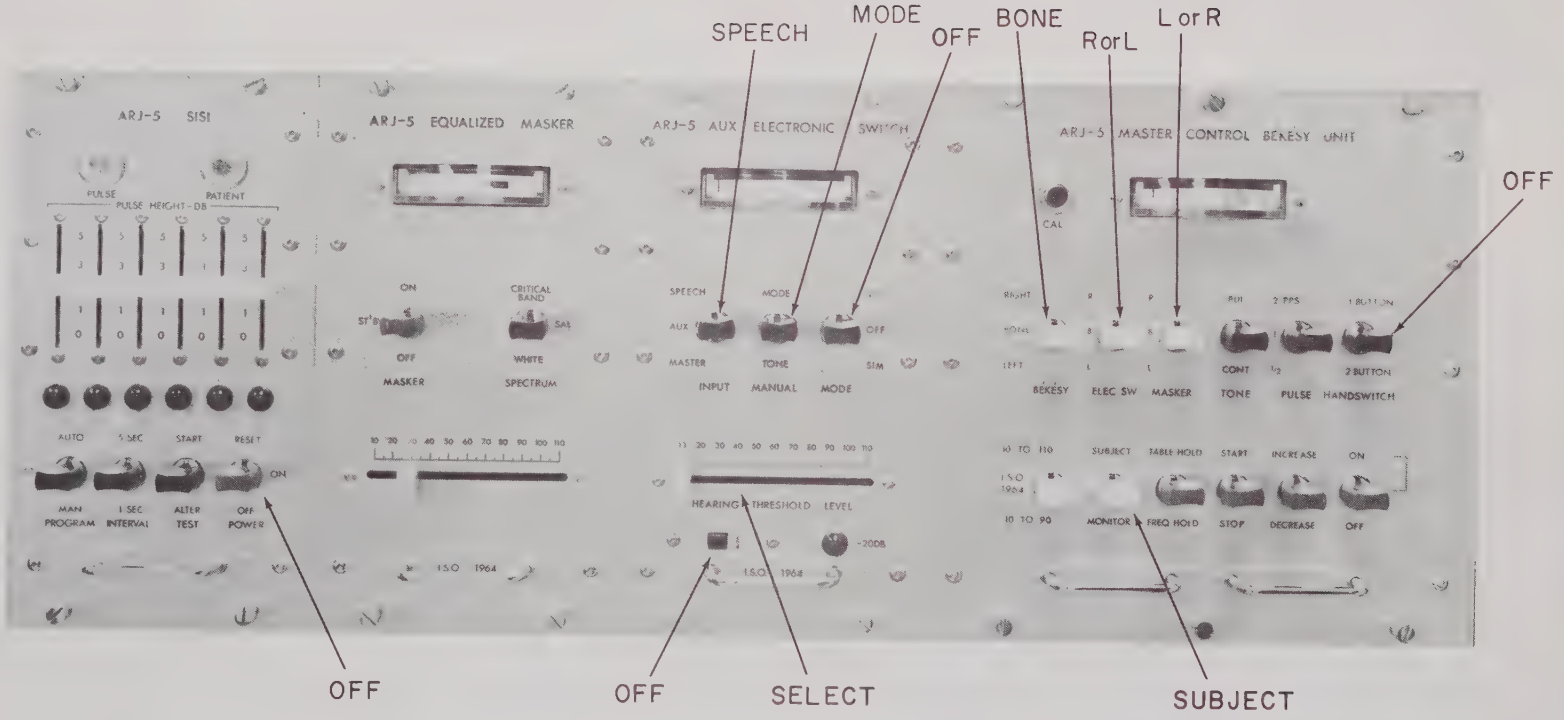


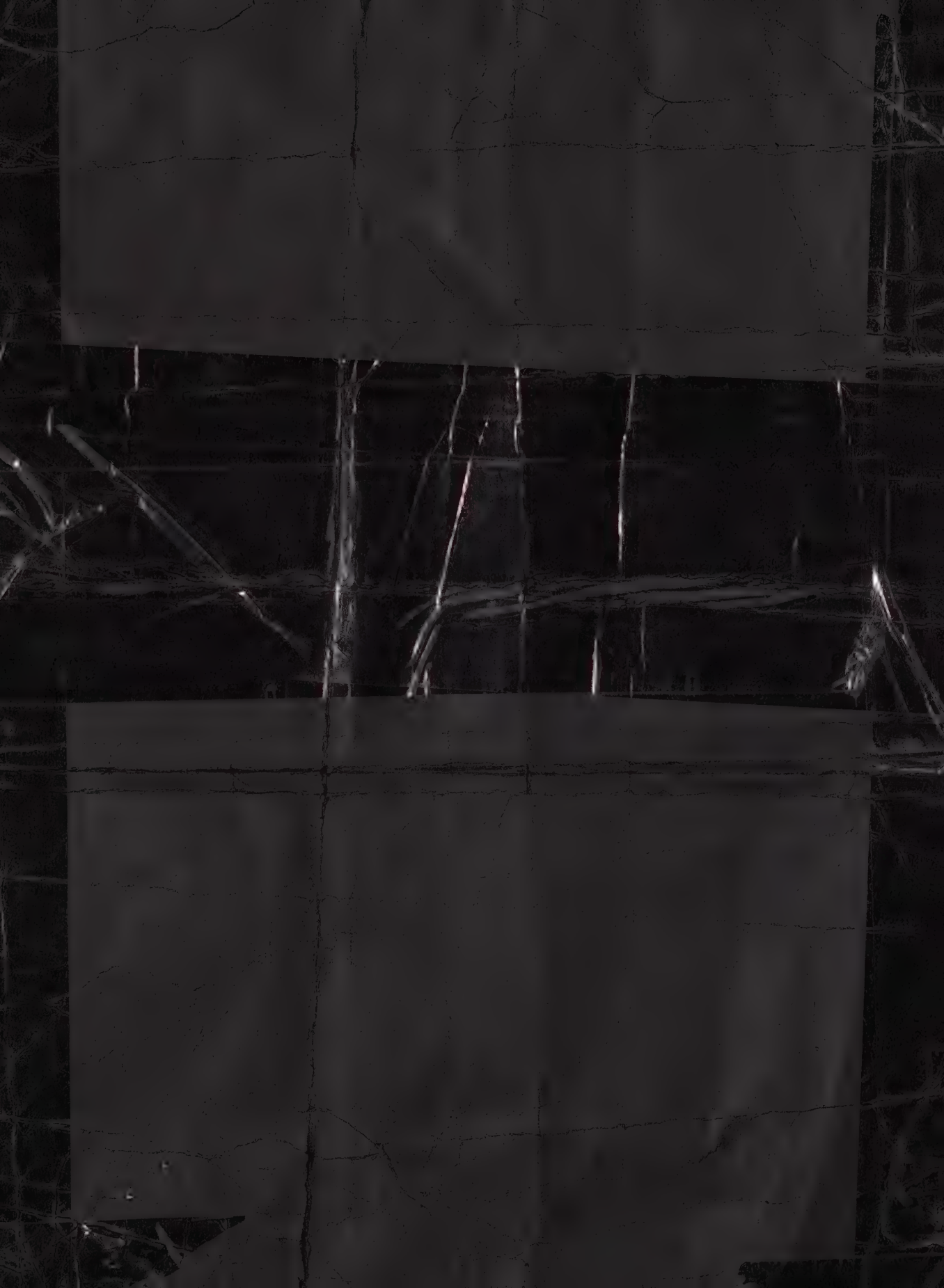
Figure 11. Speech Testing

B6-106-130 B

SPEECH TESTING

Section 11

1. Set up as shown:
   A. Plug microphone into Auxiliary Electronic Switch SPEECH 600Ω (rear panel) input jack.



2. Clinical Procedure:

A. SRT (Speech Reception Threshold) by Spondees. This is the level at which a subject can repeat a selected sample of bi-syllabic words 50% of the time.

1. Inform the subject that he will be tested one ear at a time, beginning with the better ear, and that he is to repeat the words he hears. Tell him that the words will decrease in loudness gradually, and that he will probably miss some of them. He should guess if necessary.
2. If masking is indicated by the Pure Tone Air Conduction test, inform the subject that noise will be presented to the non-test ear.
3. Present spondee words from Auditory Test W-1 at a level of 15 to 20 dB above subject's estimated threshold. (If monitored live voice is used, be careful to peak the first syllable of the spondee on zero, via VU METER.)
4. After the subject has repeated two or three words correctly, decrease the output by 5 dB. Repeat this procedure until you reach a point at which the subject is missing some words.
5. Increase the level by 5 dB, via Auxiliary Electronic Switch attenuator, and present three spondee words. If the subject repeats them correctly, decrease the intensity by 5 dB and present three more spondees. Continue decreasing in 5 dB steps until the subject misses one or more of the three words presented.
6. When the subject misses one or more of the three words, present three more spondees at the same level until a maximum of six words have been presented. If the subject misses four of the six words, increase the level by 5 dB and present up to six additional words.

7. Bracket in 5 dB steps until the subject is repeating approximately three out of six words correctly. This level is his SRT.

NOTE

When using phonograph, W-1 threshold is 10 dB lower than dial indicates because of difference in level of calibration tone and test words.

B. SRT by Running Speech

1. Instruct the subject that he will hear running speech which will become progressively softer. Instruct him to say "yes" every few seconds as long as he can understand the speaker, "no" when he can no longer understand. Tell him that he may miss a few words, but as long as he can understand the train of thought he should say "yes".
2. Start reading a passage into the microphone with the output well above the subject's threshold. After he has said "yes" two or three times, decrease the level by 5 dB. Allow him to respond "yes" two or three more times, then decrease the level by another 5 dB. Continue this procedure until the subject says "no".
3. The hearing level at which the subject last said "yes" should be noted as the subject's SRT by running speech.

C. MCL (Most Comfortable Loudness) This is the hearing level at which speech is most comfortable for the subject. Read a passage, varying the intensity levels well above threshold until the subject signals that a level

which is most comfortable for him has been reached. Make him repeat this judgement until both you and he are sure the most comfortable level has been found. Record this level as the MCL, then test the other ear by the same procedure.

D. UCL (Uncomfortable Loudness) This is the hearing level at which speech becomes uncomfortably loud, sometimes called tolerance level (TL), or threshold of discomfort (TD). Instruct the subject that you want to determine the loudest level at which he can tolerate speech. Explain that it will be louder than he would care to listen to, but that you want to find the very loudest level he can tolerate. As soon as he signals that the speech is uncomfortably loud and that he is unwilling to listen at a greater intensity, stop speaking and note the attenuator. Record this figure as the subject's tolerance level for that ear, then test the other ear in the same manner.

E. DYNAMIC RANGE - Subtract the subject's SRT from his UCL in each ear and record the difference in decibels as his dynamic range.

F. DISCRIMINATION

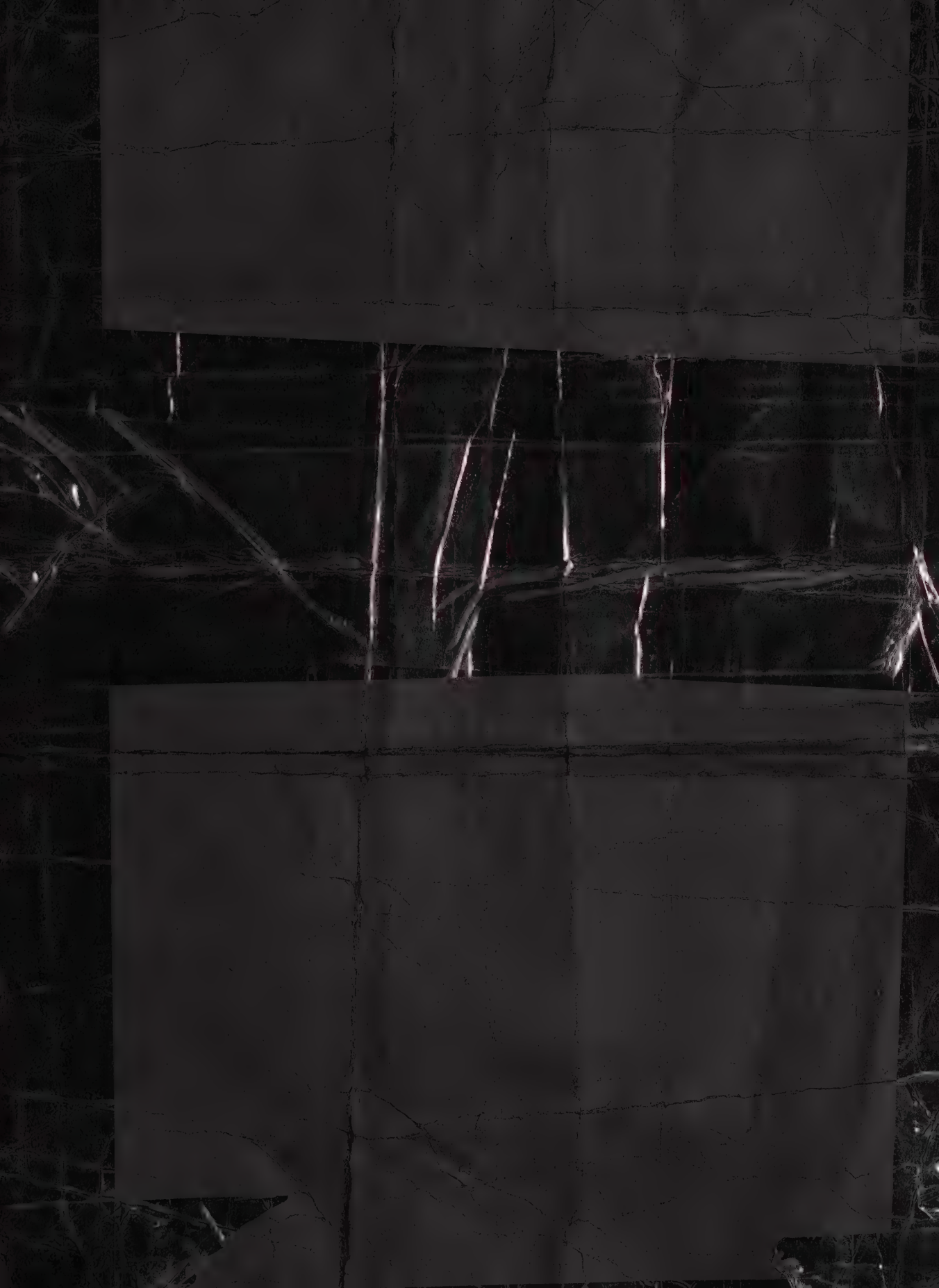
1. Instruct the subject to write down or repeat each of the fifty words that he hears.
2. Put on a W-22 tape and adjust Auxiliary Electronic Switch LEVEL control so that the calibrating tone will peak at "0" on the meter. Once this level has been established, the LEVEL control should not be touched.
3. Adjust the attenuator to 40 dB greater than the SRT for the ear being measured, unless SRT +40 dB will be greater than the UCL for that ear, in which case a lower setting will have to be used. (Be certain to record SL at which words were presented.) Then start the discrimination test.

4. Switch the output selector to the opposite ear, set the attenuator to SRT + 40 dB if possible, and present another W-22 list.
5. Score the test papers and enter the percentage correct for each ear on the audiogram after DISCRIMINATION. (Lists used and SL should be recorded on audiogram.)

3. Interpretation:
   A. SRT - This is a measure of the minimal level at which speech can be understood 50% of the time under good acoustical conditions. (SRT should be within ±5 dB of pure tone average.)
   B. MCL and UCL - These two measures have significance in determining the limits of amplification that are suitable for a subject who is a candidate for a hearing aid.
   C. DYNAMIC RANGE - For a thorough discussion, see references.
   D. The speech discrimination test is an extremely valuable diagnostic tool. Because the implications of lowered discrimination ability are many, the reader is advised to consult the references for a detailed discussion.

Reviewers' Comments:

None



PURE-TONE STENGER TEST

Section 12

Test for functional impairment in subjects with non-symmetrical or unilateral hearing loss.

References:

Davis & Silverman - pp. 226-227
Glorig - pp. 193
Langenbeck - pp. 197-200
Newby (1958) - pp. 157-158
Newby, 2nd Ed. - pp. 149-151
O'Neill & Oyer - pp. 194
Portmann & Portmann - pp. 250
Sataloff - pp. 331

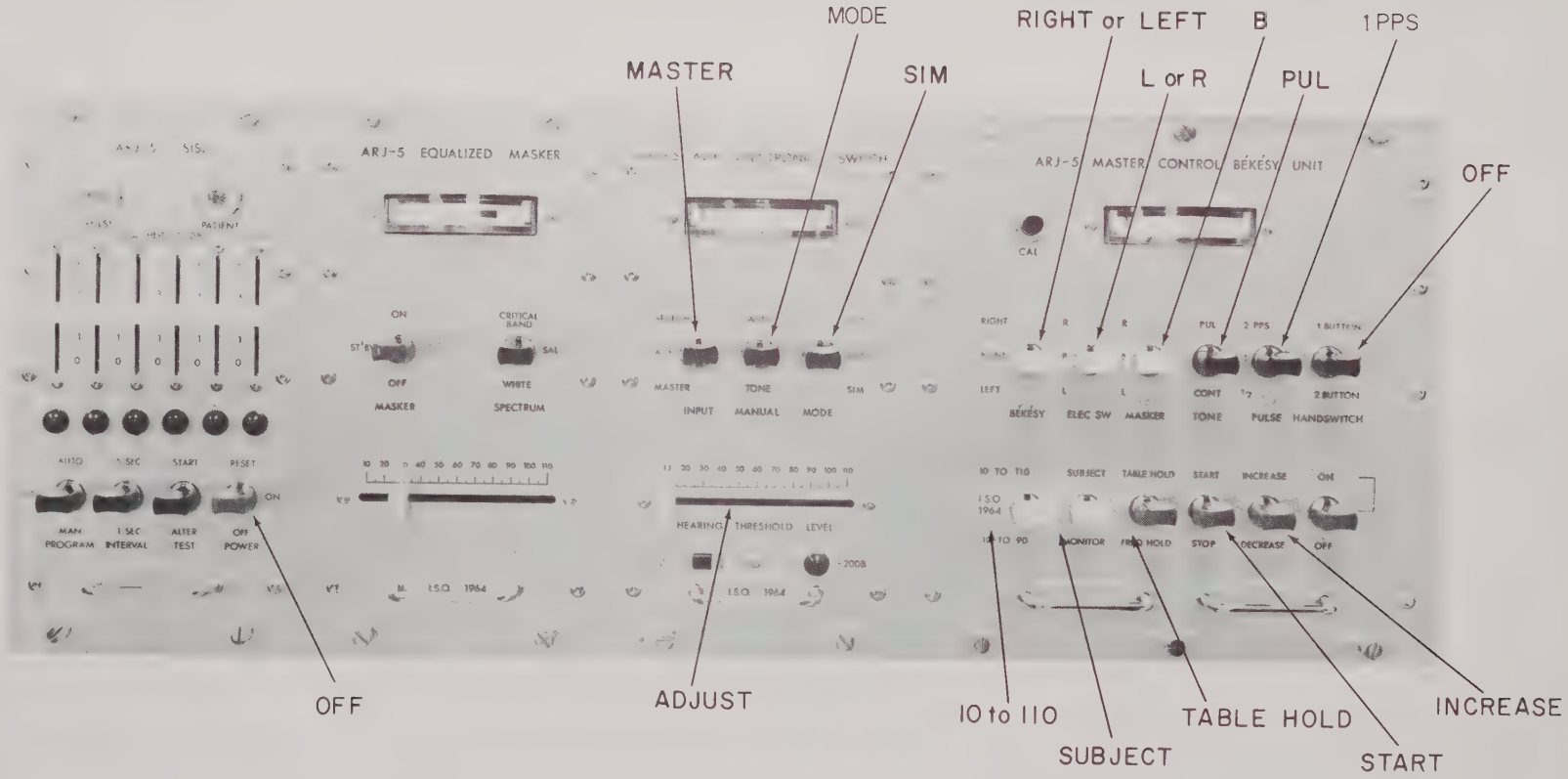


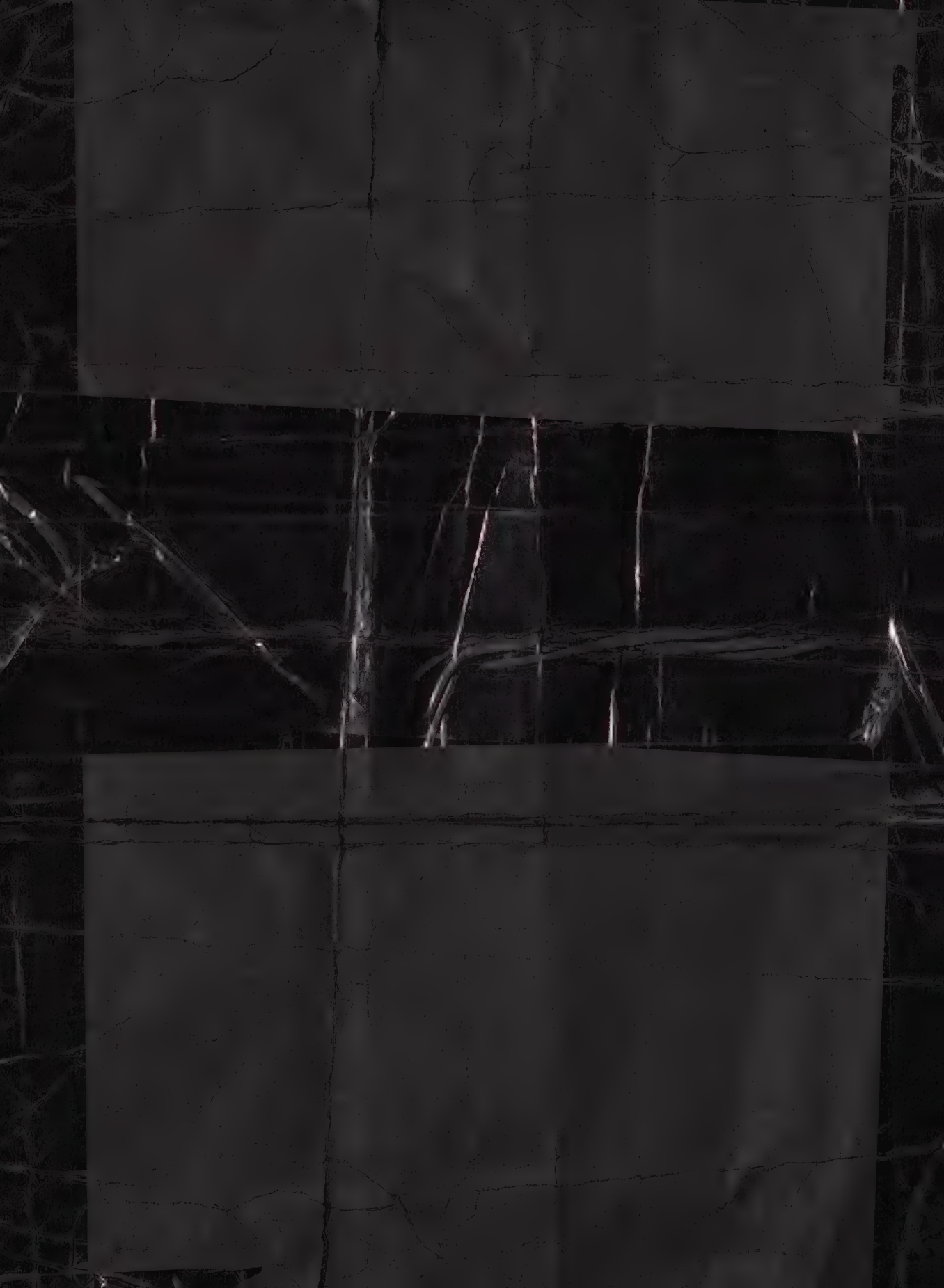
Figure 12. Pure Tone Stenger Test

B6-106-126 C

PURE TONE STENGER TEST

Section 12

1. Set up as shown:
   A. Set BÉKÉSY output for the better ear and the ELEC SW for poorer ear.
   B. Actuate INCREASE/DECREASE to INCREASE until stylus indicates a sound level 5 to 10 dB greater than the threshold for the good ear. This setting is maintained throughout the test.



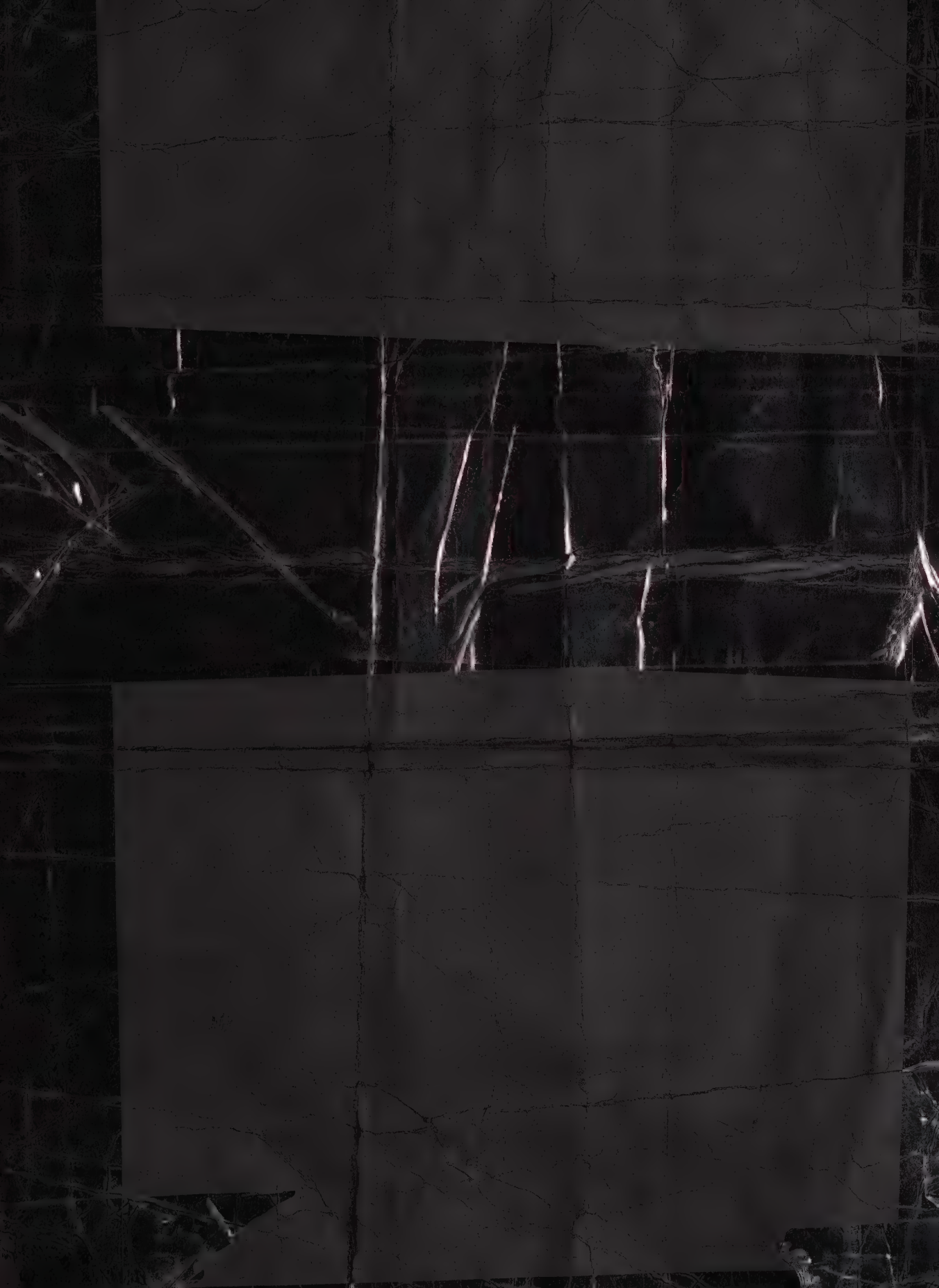
2. Clinical Procedures:
   A. Establish pure tone air conduction thresholds in each ear according to Section 4.
   B. Present a tone simultaneously to both ears at a level which is 5 to 10 dB above the threshold for the good ear.
   C. Keeping the tone in the good ear at this constant level (SL of 5 to 10 dB), gradually increase intensity of tone in "poor" ear 10 dB.
   D. If the subject indicates that he hears the tone, increase the intensity level to the "poor" ear in 10 dB steps until that point at which the subject ceases to respond to the tone. If the subject continues to respond no matter what the intensity is in the "poor" ear, the loss is probably genuine and the Stenger should be reported as "negative". If, however, the subject ceases to respond at any of the presentation levels, the level at which he ceased responding should be noted and the Stenger classified as "positive" - indicative of a functional hearing loss.
   E. The Pure Tone Stenger test may not be effective for subjects having diplacusis at any of the test frequencies.

3. Interpretation:
   A. If an actual hearing loss exists, the subject will continue to report that he hears the tone regardless of the intensity level presented to the "poor" ear. (Negative Stenger)
   B. If the loss is functional, the subject will stop signaling that he hears the tone when the intensity level presented to the "poor" ear becomes greater than that level presented to his "good" ear. (Positive Stenger)

The subject does not realize that the tone is still present is his "good" ear because he has the sensation of hearing it only in his "poor" ear due to the increased intensity.

Reviewers' Comments:

"To verify the "probable" genuine loss, decrease the HTL in the good ear below threshold, while leaving the test tone in the "poor" ear at a level greater than the HTL of the good ear. The patient's response should cease as soon as the tone in his good ear is below threshold."



LOMBARD TEST
OR
VOICE-REFLEX TEST

Section 13

Test for functional impairment

References:

Davis & Silverman - pp. 225-226
Glorig - pp. 193
Langenbeck - pp. 200-201
Newby (1958) - pp. 156
Newby, 2nd Ed. - pp. 148-149
O'Neill & Oyer - pp. 194-195
Portmann & Portmann - pp. 247-248
Sataloff - pp. 330

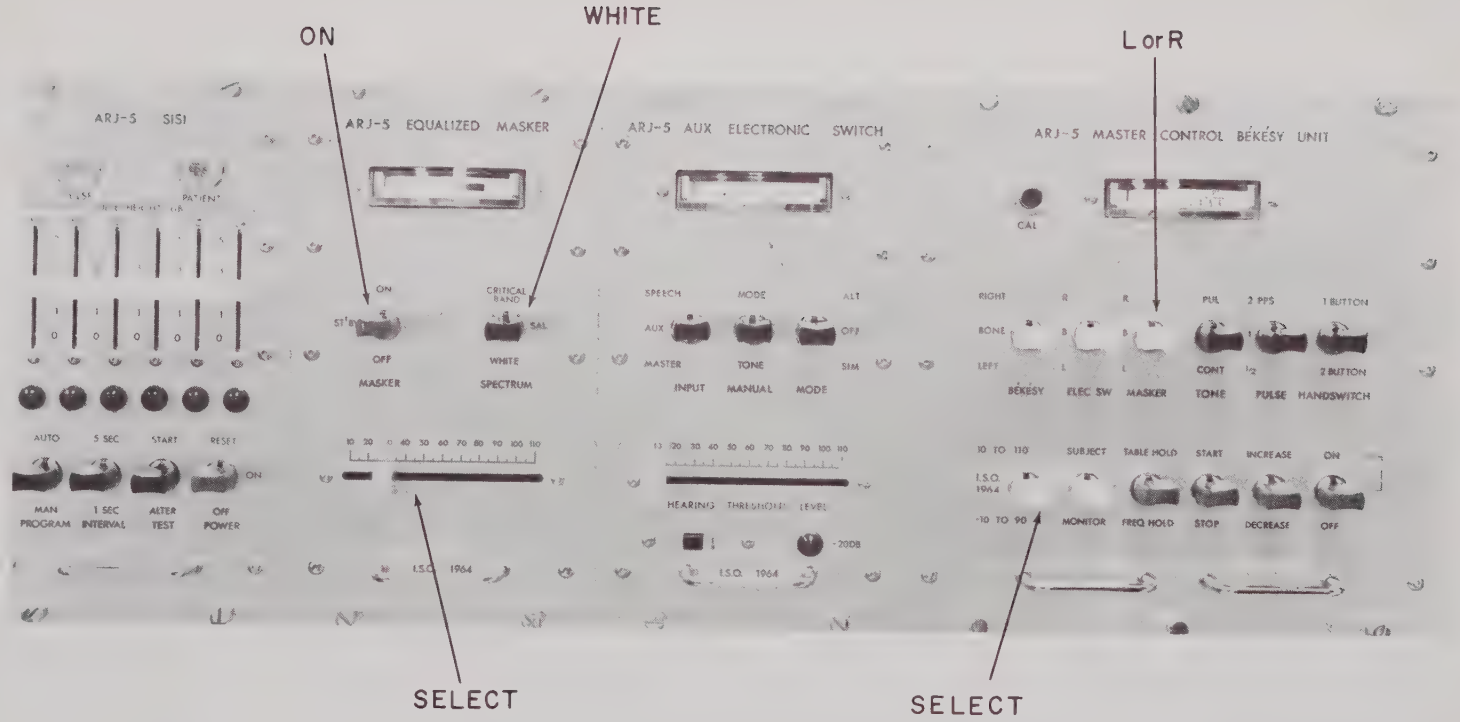


Figure 13. Lombard Test

B6-106-1338

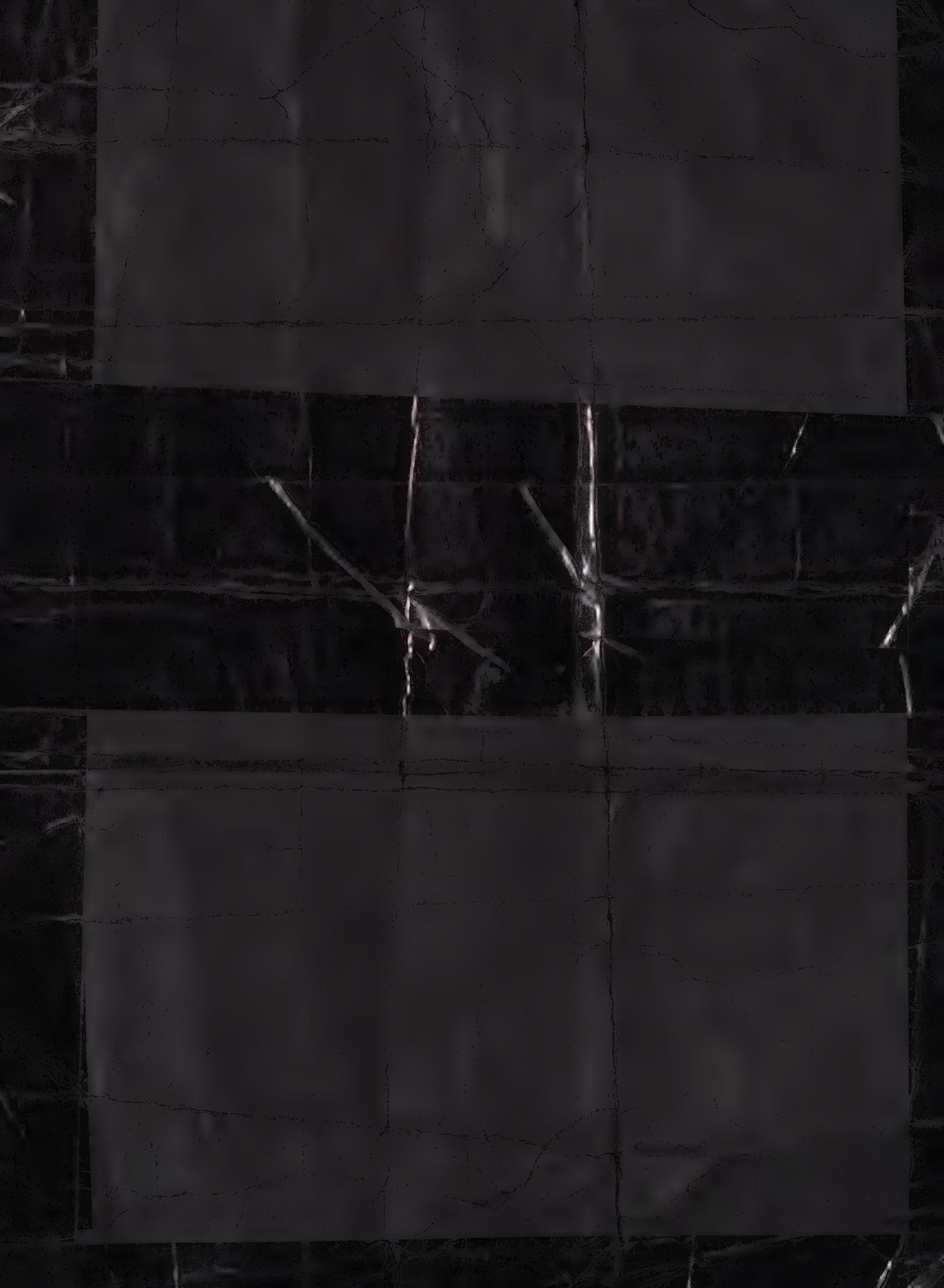
LOMBARD TEST OR VOICE-REFLEX TEST

Section 13

1. Set up as shown.

2. Clinical Procedure:
   A. Give the subject some material to read aloud with headsets on.
   B. Establish his normal speech level before masking.
   C. While subject is reading, introduce masking noise through air conduction receiver to poor ear, and gradually increase the noise intensity. Note level of masking at which subject's voice becomes more intense.
   D. Repeat procedure to better ear and note level of masking required to change voice level.
   E. Compare levels of masking required for each ear.

3. Interpretation:
   This test is based on the fact that when speaking in a noisy environment, one unconsciously increases the intensity of his voice to compensate for the masking effect of the noise. The limitations of the Lombard Test are that an accurate measure of the subject's true threshold is not obtained, and a sophisticated subject can control the intensity of his voice even in the presence of an extremely loud masking noise.
   A. If the subject's voice does not increase in intensity until masking noise is presented to the poor ear at a level above his previously established



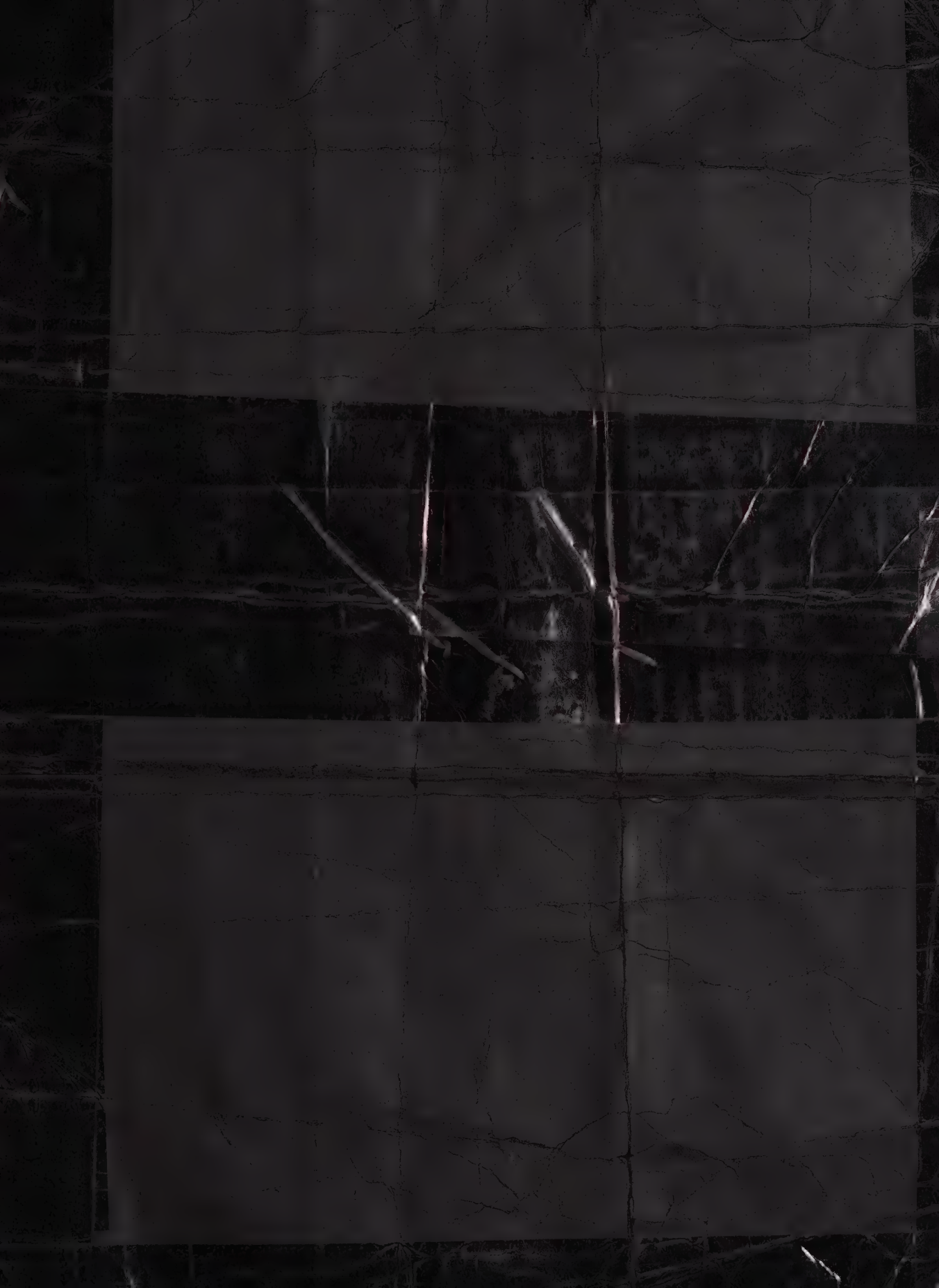
threshold for that ear, his loss may be genuine. (Negative Lombard)

B. If the subject's voice increases in intensity when masking noise is presented to the poor ear at a level below his established threshold for that ear, the subject is hearing at a lower level than that which was previously established. (Positive Lombard)

C. If masking levels required to change voice intensity are similar for both ears, it may be assumed that hearing level for both ears is similar.

Reviewers' Comments:

None



MODIFIED DOERFLER-STEWART TEST

Section 14

Test for functional impairment

References:

Davis & Silverman - pp. 226
Glorig - pp. 194
Newby (1958) - pp. 159-164
Newby, 2nd Ed. - pp. 160-161
O'Neill & Oyer - pp. 197-199

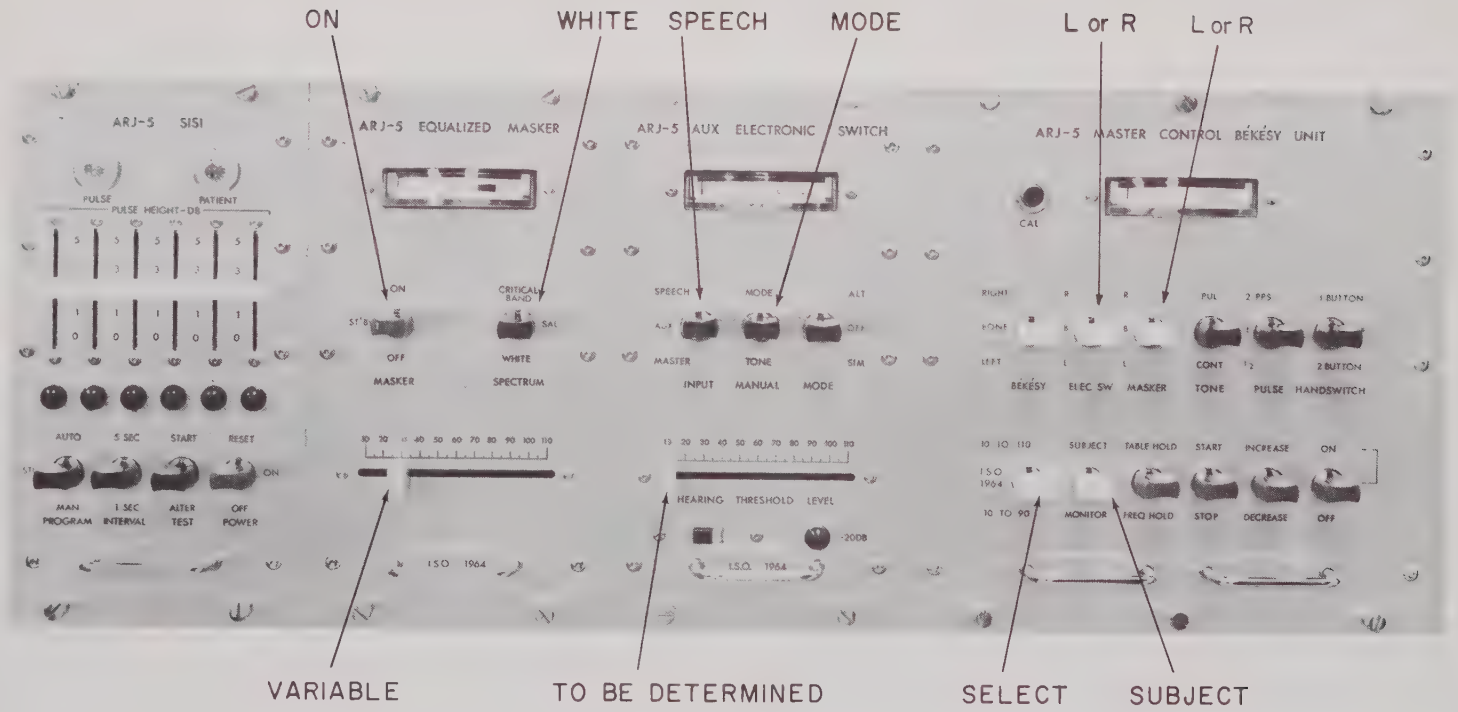


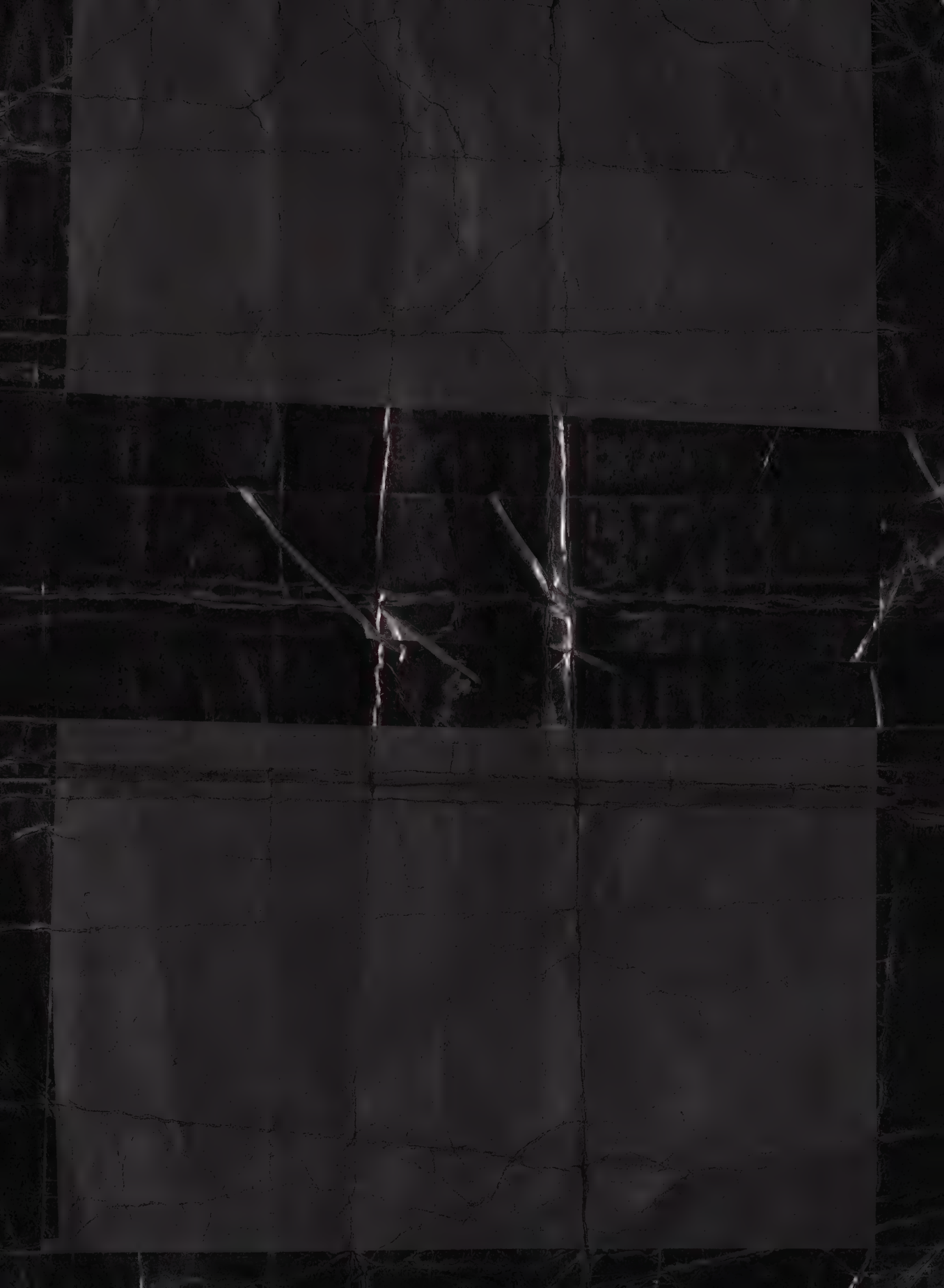
Figure 14. Modified Doerfler-Stewart Test

B6-106-118 C

Section 14

1. Set up as shown:

   A. Set Auxiliary Electronic Switch HEARING THRESHOLD LEVEL at 10 dB.
   B. Set Equalized Masker attenuator to lowest level.
   C. Plug microphone into Auxiliary Electronic Switch SPEECH 600 Ω (rear panel) input jack.
   D. Auxiliary Electronic Switch and Equalized Masker should be set on the same ear.



2. Clinical Procedure:

Since audiometers differ due to the type of masking noise and the method of calibration, it is difficult to give absolute rules for interpreting the dial readings. It is necessary to establish a set of "expected" responses based on sample results from individuals with normal hearing and on known non-malingerers with both conductive and sensorineural losses. Once these sample responses have been established, proceed with the steps outlined below for cases of suspected functional hearing loss to determine whether or not the patient's responses vary substantially from "expected performance."

A. D-S test should be administered before any standard speech audiometry is attempted in instances where functional impairment is suspected.
B. The MASKER switch on the Equalized Masker should remain at ST'BY until the speech-reception threshold (SRT) is obtained.
C. Determine the SRT for spondees by starting with the Auxiliary Electronic Switch HEARING THRESHOLD LEVEL set at 10 dB. Present three spondees at that level, increase the intensity level by 5 dB, and present three more spondees. Increase the intensity by 5 dB for each set of three spondees presented until the subject repeats two of the three spondees correctly.
    1. This will be the subject's SRT provided that when the intensity is increased by another 5 dB he usually repeats the next three spondees correctly.
    2. If at this higher level he does not repeat all three words correctly, present six more spondees at the same level. If he repeats more than three of them correctly, decrease the intensity by 5 dB steps for each set of six spondees until the subject is unable to repeat half of the

six words correctly. His SRT will then be defined as the point 5 dB above the level at which he failed to repeat half of the words correctly. Record the SRT as $SRT_{(1)}$.

D. Increase the intensity to 5 dB above the subject's SRT and record this figure as $SRT_{(1)} + 5$. Subject should be able to respond correctly 90-100% of the time.

E. Introduce white noise via the Equalized Masker attenuator at a level below the expected threshold of masking. Increase the noise by 5 dB per spondee until the subject fails to repeat three or four consecutive words. Record the level of the noise at this point as NIL (noise interference level).

F. Continue presenting the spondees at the level of $SRT_{(1)} + 5$, but gradually increase the noise intensity by 5 dB per spondee until the noise is at least 20 dB above the NIL, or at least 30 dB above $SRT_{(1)} + 5$, whichever point comes first.

G. Keeping the noise at the level reached in the preceding step, decrease the intensity of the spondees by 5 dB per word until they are being presented at a level 10 dB below $SRT_{(1)}$.

H. Decrease the level of the noise by 10 dB per spondee until the noise level is equal to $SRT_{(1)}$; then decrease the noise by 5 dB per word until it is completely attenuated (sensation level of zero). If the subject should start repeating words again as the noise is decreased, record the level of speech at this point as $SRT_{(1)} - 10$, and, keeping the noise constant, decrease the level of the spondees again until the subject no longer responds. Resume the decrease of noise in 5 dB steps. If the subject responds again, repeat this procedure until the noise is completely attenuated.

I. Presenting the spondee words at the level of $SRT_{(1)}$ -10, or at the level at which the subject last responded during the preceding step if any responses were obtained while the noise was being decreased, proceed to find the subject's SRT again in the same manner as in Step C. Record this SRT as $SRT_{(2)}$.

J. Discontinue the presentation of spondees (for the first time since the start of the test). Instruct the subject to signal you when he first detects the presence of the masking noise. Start the noise at some level below the expected masking threshold and gradually increase the intensity of the noise until the subject signals he detects it. Record the noise level at this point as NDT (noise detection threshold). The test is now complete.

3. Interpretation:

The D-S test is positive, i.e., functional loss is suggested, if the following results are obtained:

A. The difference between $SRT_{(1)}$ and $SRT_{(2)}$ differs by more than ±5 dB.

B. NIL is 10 dB less than normally expected or is 20 dB greater than normally expected.

C. NDT-$SRT_{(1)}$ or $SRT_{(2)}$ is more than 7 dB or less than 15 dB.

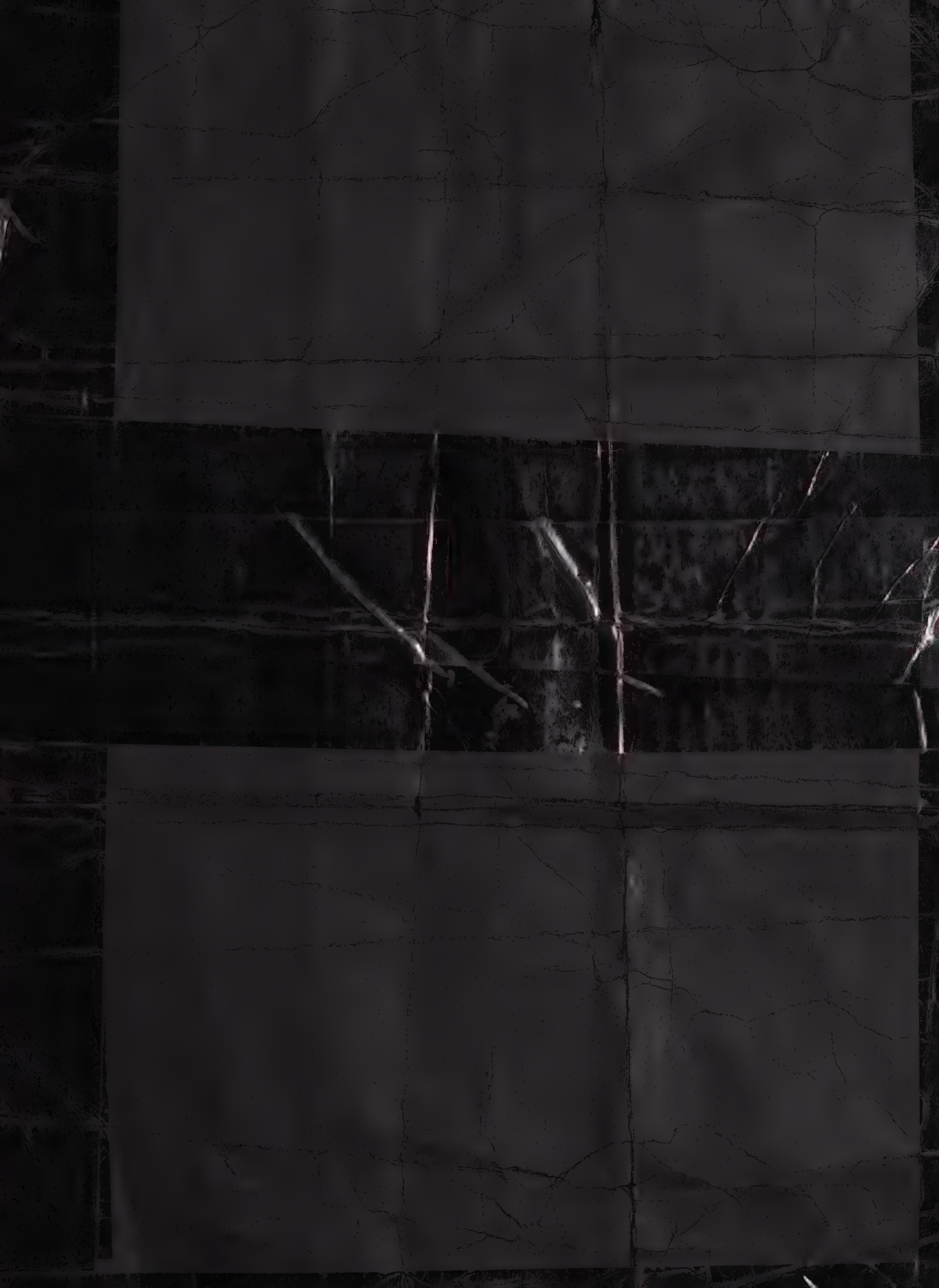
D. NDT is more than 2 dB greater than NIL or less than 31 dB below NIL.

Result A should be weighted less heavily than Results B, C, and D since measures of NIL and NDT are more sensitive indicators of functional loss than measures involving the SRT. Furthermore, the actual decibel values listed above should be considered as guides. Norms should be established for each audiometer.

Reviewers'Comments:

"The results seem somewhat lenient to me. If a patient fails to meet these criteria, he would most certainly be a non-organic case. At our Center, with D-S noise we use:

A. $SRT_{(1)} - SRT_{(2)} > \pm 3$ dB
B. +10 to +38 dB
C. +3 to -15 dB
D. We do not use. "



MONAURAL THRESHOLD FINDING THROUGH BINAURAL FUSION
(Fusion at the Inferred Threshold)
FIT TEST

Section 15

Use when functional impairment is suspected

References:

Bergman, M. "The Fit Test, Monaural Threshold Finding Through Binaural Fusion", Archives of Otolaryngology, 80: 440-449, October, 1964.

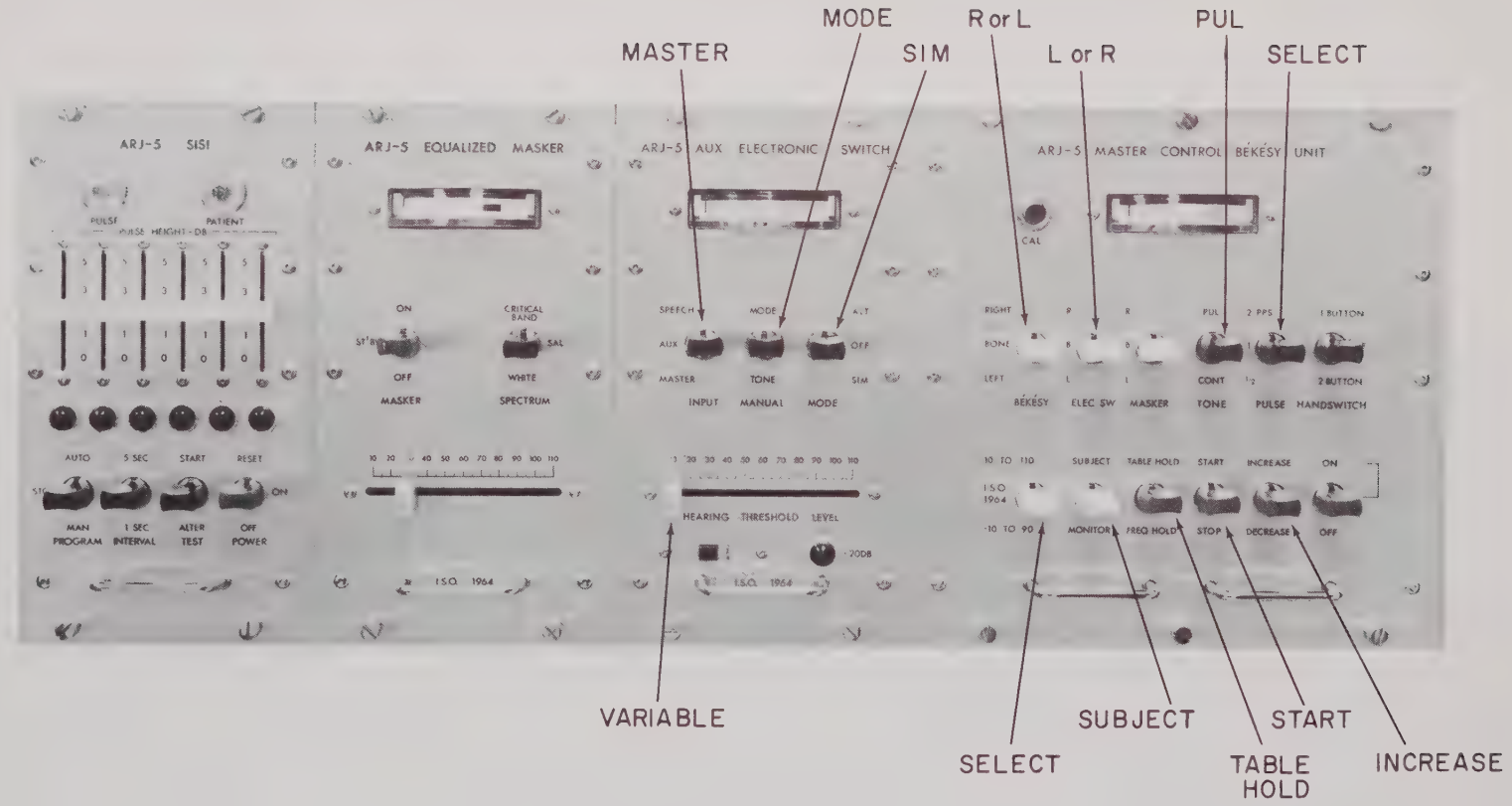


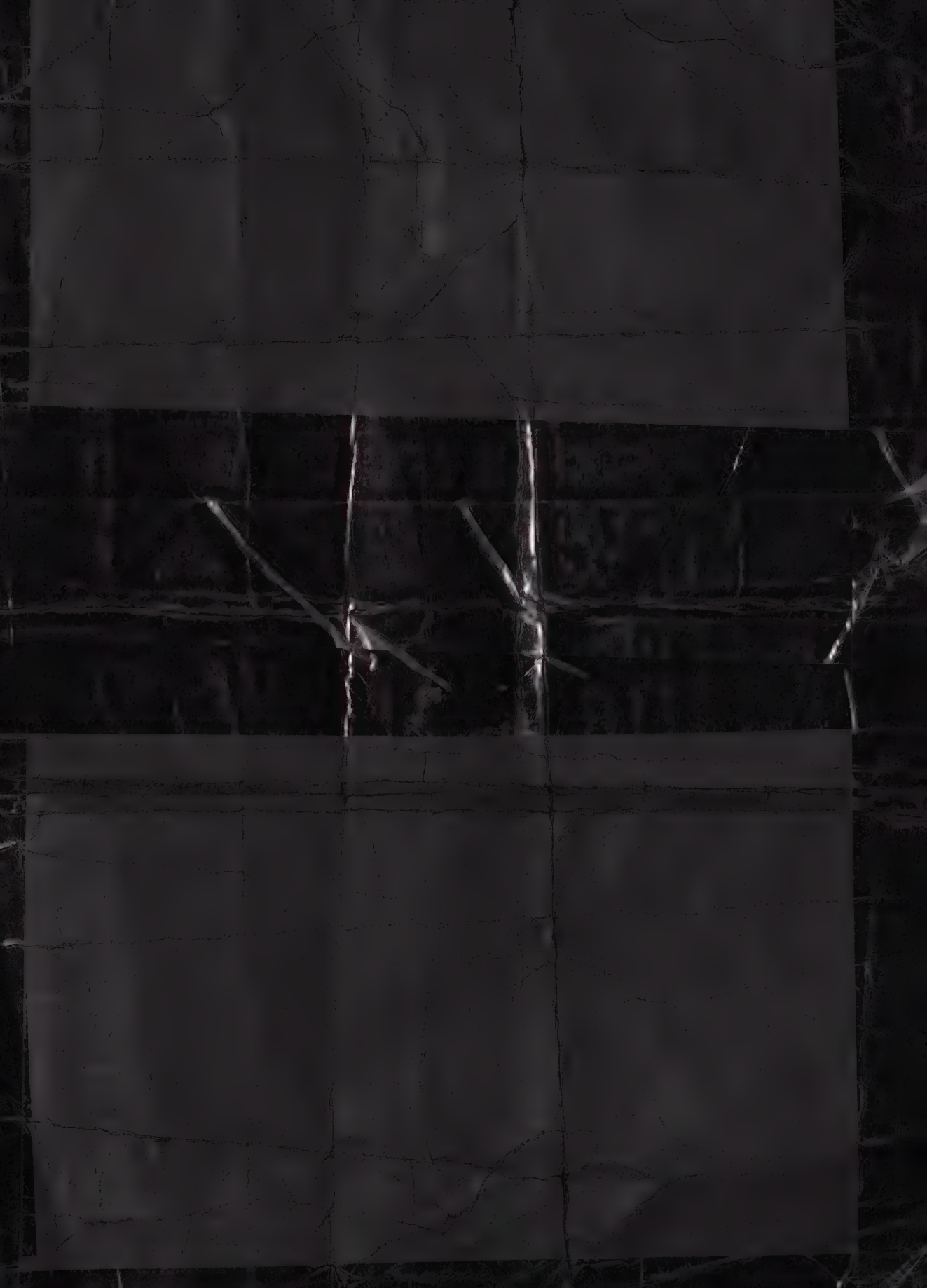
Figure 15. Fit Test

B6-106-118 B

FIT TEST

Section 15

1. Set up as shown:
   A. Set table at desired frequency position.
   B. Increase intensity through Auxiliary Electronic Switch attenuator.



2. Clinical Procedure:

A. Instruct the subject that he will hear a series of pulsed tones in his (better) ear, and that after awhile the tone may seem to move out of the ear and up the head. Tell him to let you know (via hand switch or hand signal) as soon as the tone seems to move out of his ear, and when it moves back to the ear.

B. Present tone, through Master Control Békésy unit, to better ear at a level 5 dB above threshold.

C. Start below threshold for test ear on Auxiliary Electronic Switch module, and increase intensity of tone in 5 dB steps until subject responds.

D. Increase and decrease intensity of tone in test ear until the level is determined at which the subject responds 50% of the time.

E. Continue this procedure for each frequency to be tested.

F. An alternate procedure, which will provide a written record, may be performed by presenting the tone to the better ear via the Auxiliary Electronic Switch module and the tone to the poorer ear via the Master Control Békésy unit. The subject should "press and hold" the handswitch as soon as the tone leaves the better ear, and "release" as soon as the tone returns.

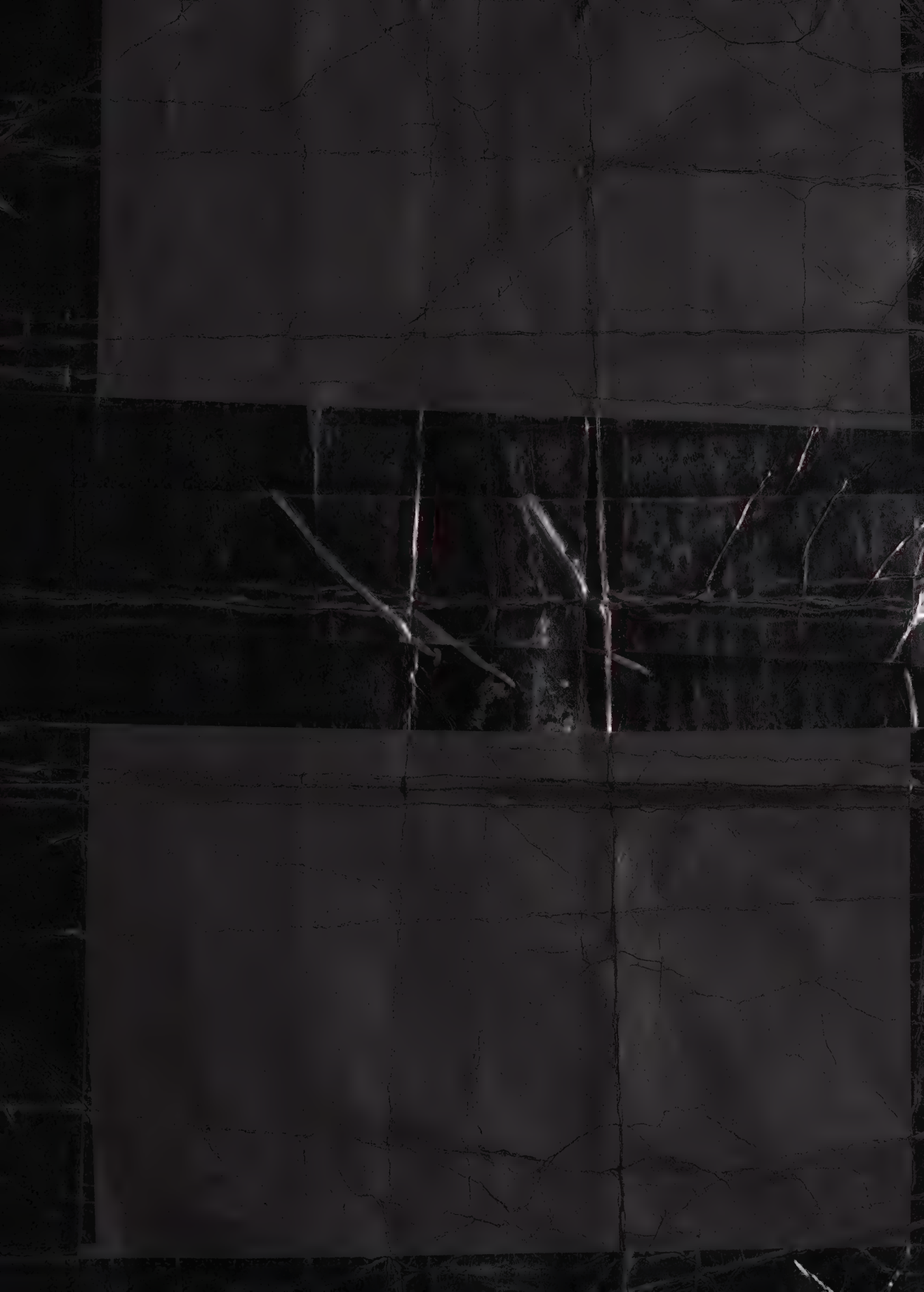
3. Interpretation:

Results of the FIT Test with people with normal hearing and organic hearing loss should be within 5 dB of results obtained by orthodox detection methods. The FIT Test may be used in cases which would ordinarily require masking. Cases of malingering may be detected when the fusion threshold is lower than the pure-tone threshold obtained by previous testing.

The FIT Test is excellent in situations where air conduction thresholds of the two ears differ by a great deal and the use of masking is troublesome. The threshold of the poorer ear is determined by the point where the tone begins to move out of the better ear.

Reviewers' Comments:

None



BING OR OCCLUSION TEST

Section 16

Sensorineural loss

References:

Glorig - pp. 125-129
Portmann & Portmann - pp. 12

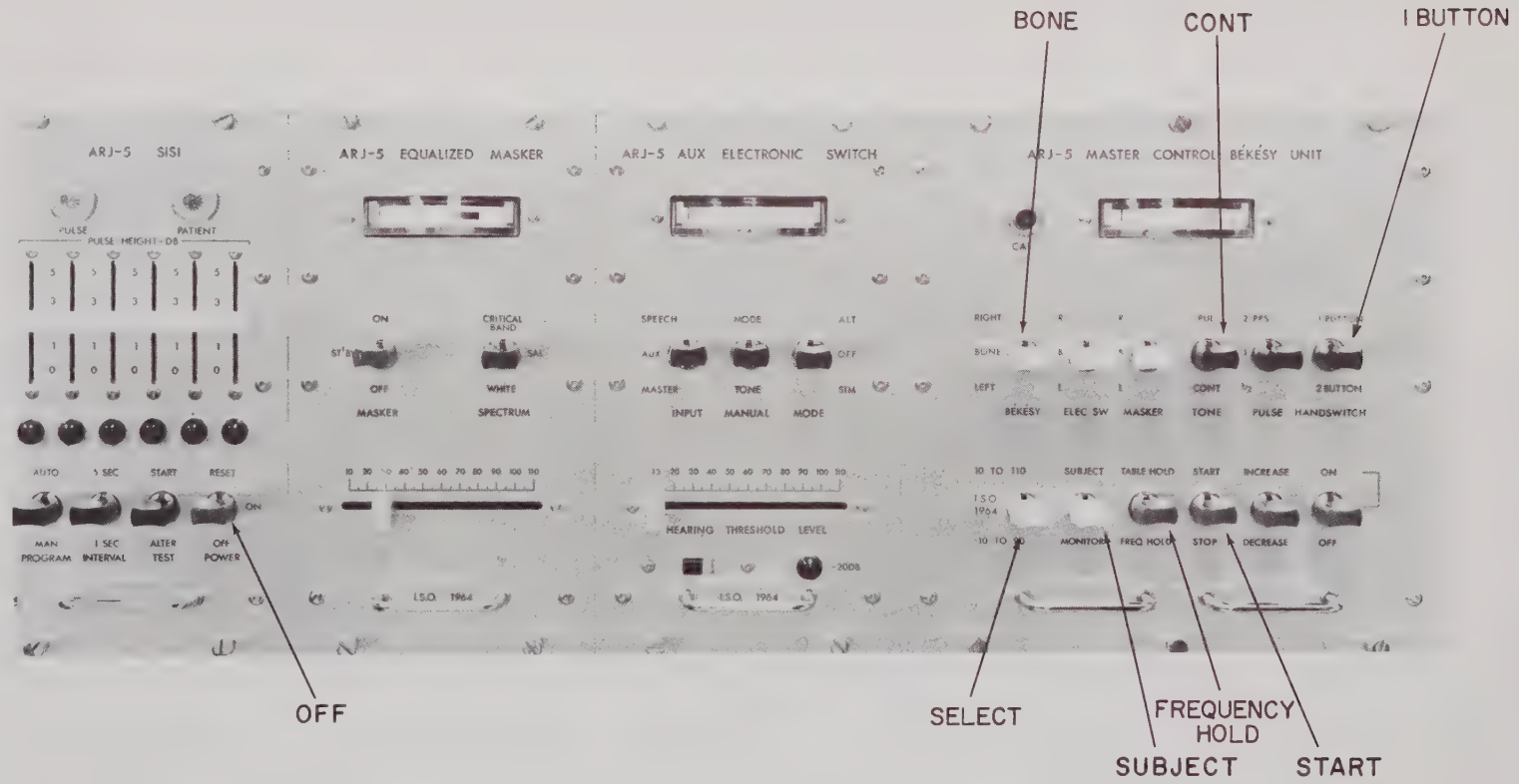


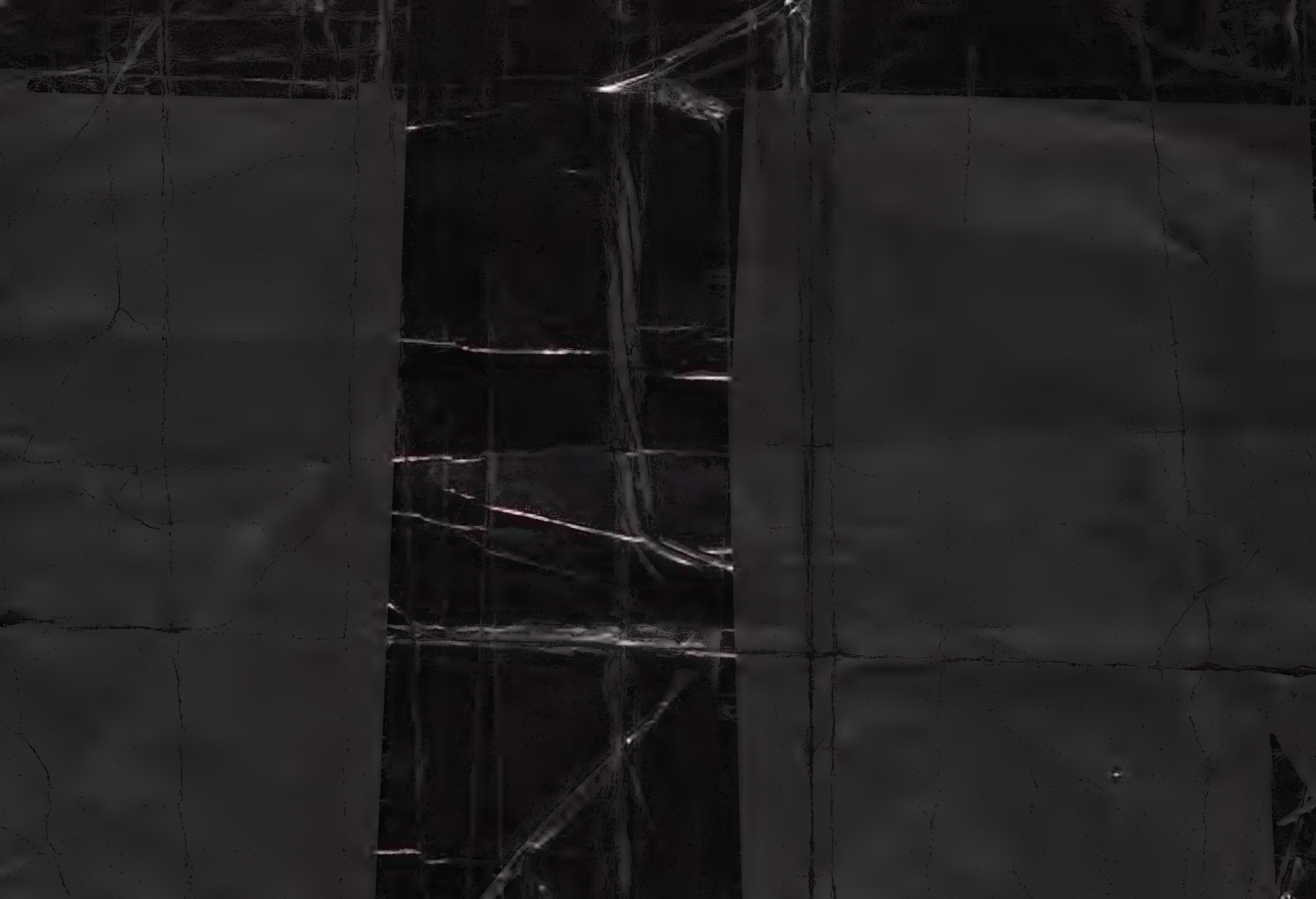
Figure 16. Bing or Occlusion Test

B6-106-133 C

BING OR OCCLUSION TEST

Section 16

1. Set up as shown:
   A. Plug bone vibrator into Master Control Békésy BONE (rear panel) output jack.
   B. Set frequency table to 500 Hz.

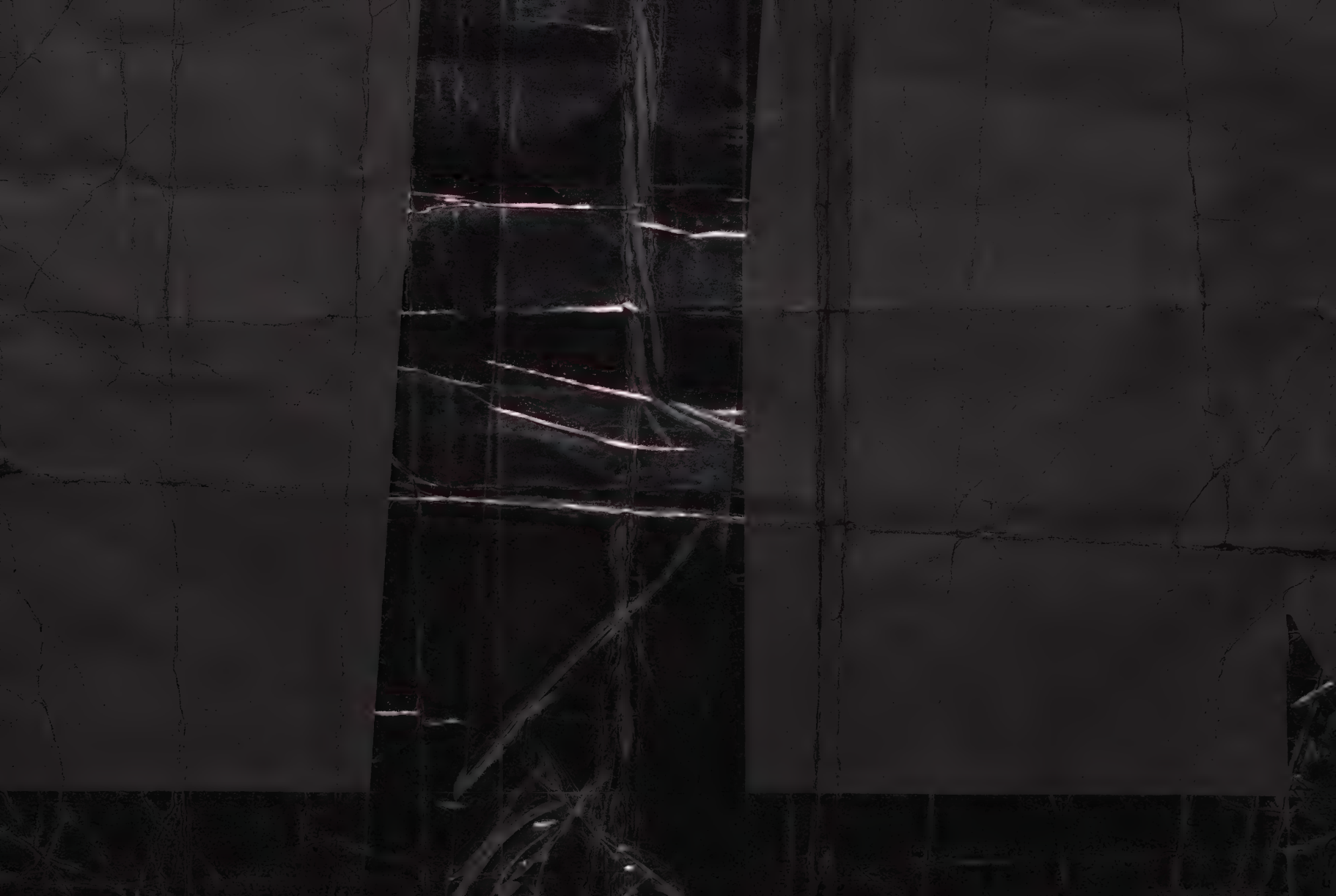


2. Clinical Procedure:
   A. Present a 500 Hz tone at a comfortable loudness level through the bone conduction vibrator to the desired ear, and have the patient trace his threshold on the audiogram card.
   B. Instruct the subject to close the ear canal by putting his hand over his ear or by pressing his finger against the tragus.
   C. With the ear occluded, have the subject take another test on the same card (using a different color).
   D. Repeat for opposite ear if desired.

3. Interpretation:
   If the threshold improves (Bing positive), the middle ear structures possess normal function and the subject has a sensorineural loss. If the thresholds are the same, the subject has a conductive loss. It is not unusual for a subject to maintain that the tone sounds softer, because he expects it to be softer when the ear is plugged.

Reviewers' Comments:

None



SIMULTANEOUS MEDIAN PLANE BALANCE

Section 17

References:

Jerger, J. F. and Harford, E. R., "Alternate and Simultaneous Binaural Balancing of Pure Tones", Journal of Speech and Hearing Research, 3: 20, (March, 1960).

Jerger (1963) - pp. 291-295

Newby, 2nd Ed. - pp. 179-181

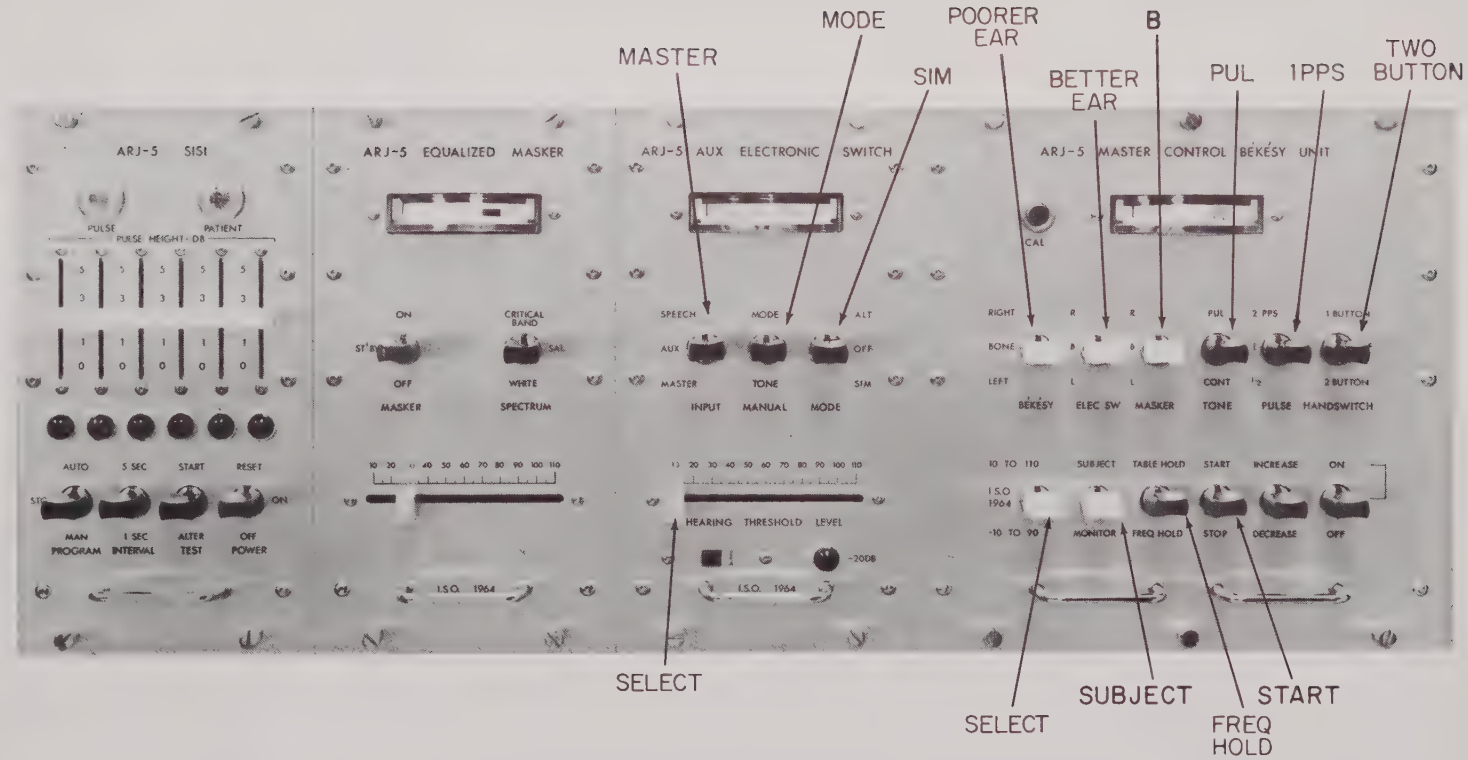


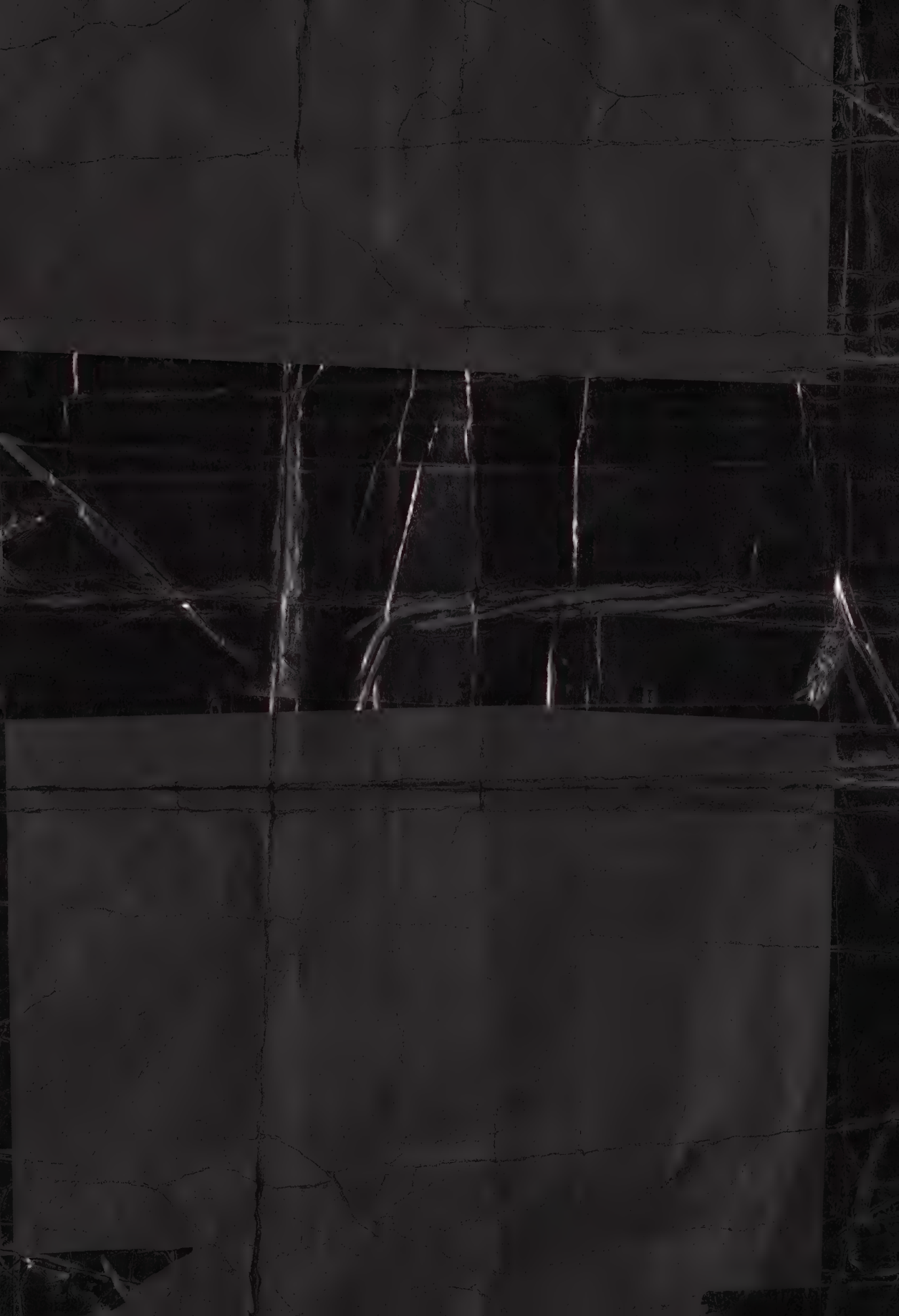
Figure 17. Simultaneous Median Plane Balance

B6-106-118 D

SIMULTANEOUS MEDIAN PLANE BALANCE

Section 17

1. Set up as shown:
   A. Set table at desired frequency position.
   B. Plug two-button handswitch into Master Control Békésy 2--H.S. (rear panel) input jack.
   C. Continuously monitor test by watching the audiogram card. When the sweeps become small and the subject has localized the signal in the center of his head, increase the presentation intensity level to the better ear (via the Auxiliary Electronic Switch unit) by 20 dB, and have the subject repeat the localization at this level. Continue this process until the limits of the audiometer have been reached in the better ear.
   D. For alternate procedure (see 2.K. - M. below), replace the two-button handswitch (rear panel) with the one-button handswitch.



2. Clinical Procedure:

   A. Select the frequency to be tested and set the TABLE HOLD/FREQ HOLD to FREQ HOLD.

   B. Instruct the subject to adjust the intensity of the tone to his poorer ear until the two tones seem to merge and become localized in the center of the head. (Press LOUDER if the tone seems to be localized more in the better ear; press SOFTER if the tone seems to be localized in the poorer ear. Release both buttons to make judgement.)

   C. By use of the Auxiliary Electronic Switch unit, present a tone to the subject's better ear 20 dB above threshold.

   D. Present the tone to the poorer ear via the Békésy unit at an arbitrary level above the reported threshold for that ear.

   E. Note the level when the subject centers the two tones by the even line on the audiogram card (less than a 10 dB span in the sweeps).

   F. When the subject has completed the median-plane localization, increase the intensity to the better ear by 20 dB and repeat the process.

   G. Continue increasing the intensity to the better ear in 20 dB steps until the maximum intensity level of the audiometer has been reached.

   H. Follow the above procedure for each desired frequency, inserting a new audiogram card for each frequency tested.

   I. To record the results, draw a line through the middle of the sweeps at each centering and record to the nearest 5 dB. This is the intensity level required to center the two tones.

   J. Plot a laddergram using these results as shown in Section 18.

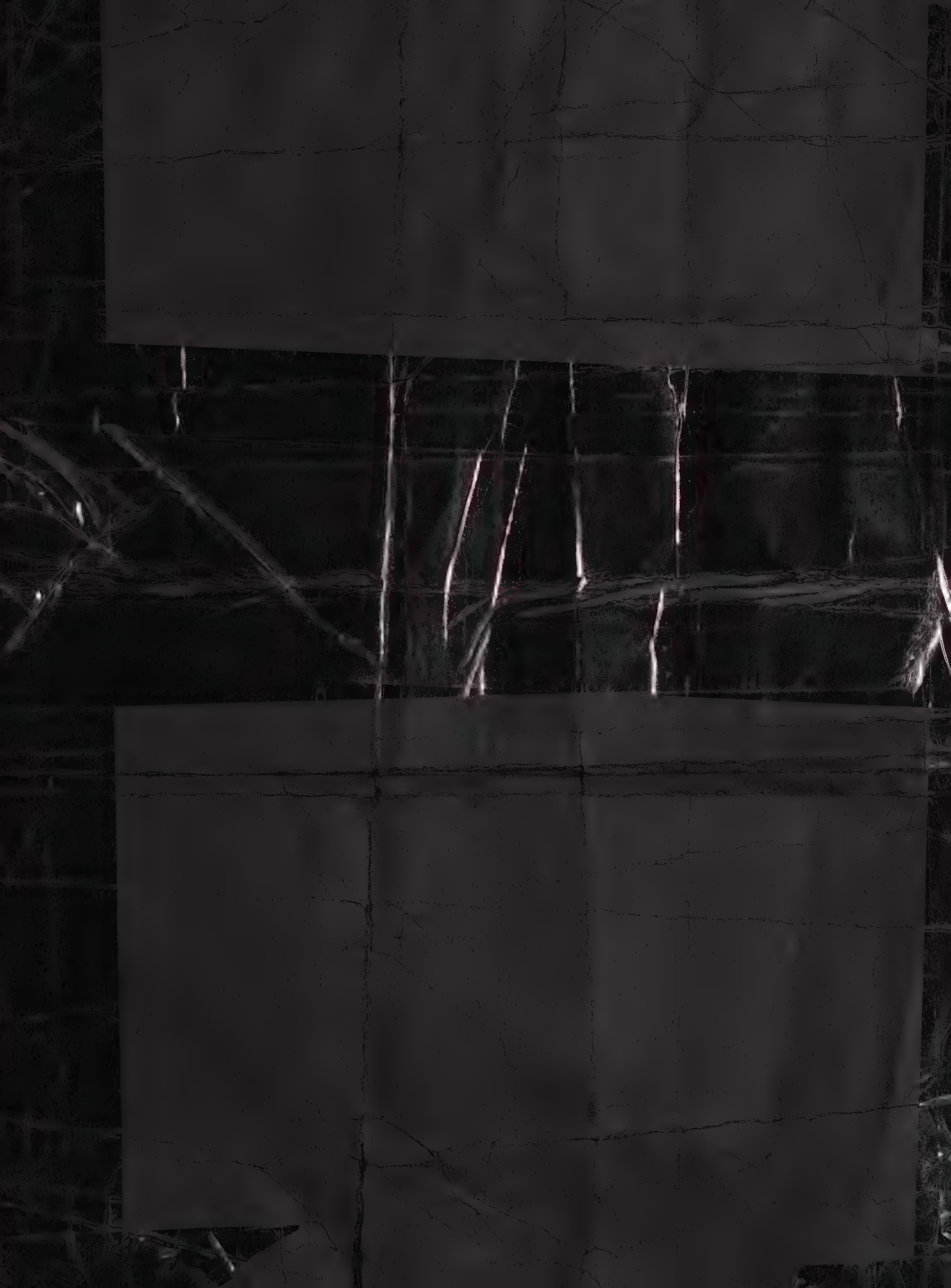
K. For procedure using the one-button handswitch, instruct the subject to press and hold the switch when the tone seems to be localized just past the head centerline and towards the poorer ear. When the tone seems to pass the head centerline and is moving toward the better ear, release the switch. The object is to try to keep the tone in the center of the head.

L. Typical Békésy swings will result when the patient is keeping the tone "centered" in the head.

M. Follow steps F.-J. above, using the one-button switch procedure.

3. Interpretation:

Median-plane localization does not infer equal loudness, and simultaneous loudness balance results are apparently not interchangeable with alternate binaural loudness balance results (Jerger and Harford). Results from median-plane localization are useful in site of lesion studies and experiments. The ultimate clinical applicability of simultaneous median plane balancing has yet to be established, but the ARJ-5 is adaptable for research in this or other areas where balancing of this type is required.



SUBJECT CONTROLLED ABLB

Section 18

Sensorineural loss
Recruitment

References:

Davis & Silverman - pp. 223
Glorig - pp. 135-137
Hirsh - pp. 217-221
Langenbeck - pp. 104-111
Newby, 2nd Ed. - pp. 163-166
Portmann - pp. 43-48
Sataloff - pp. 322

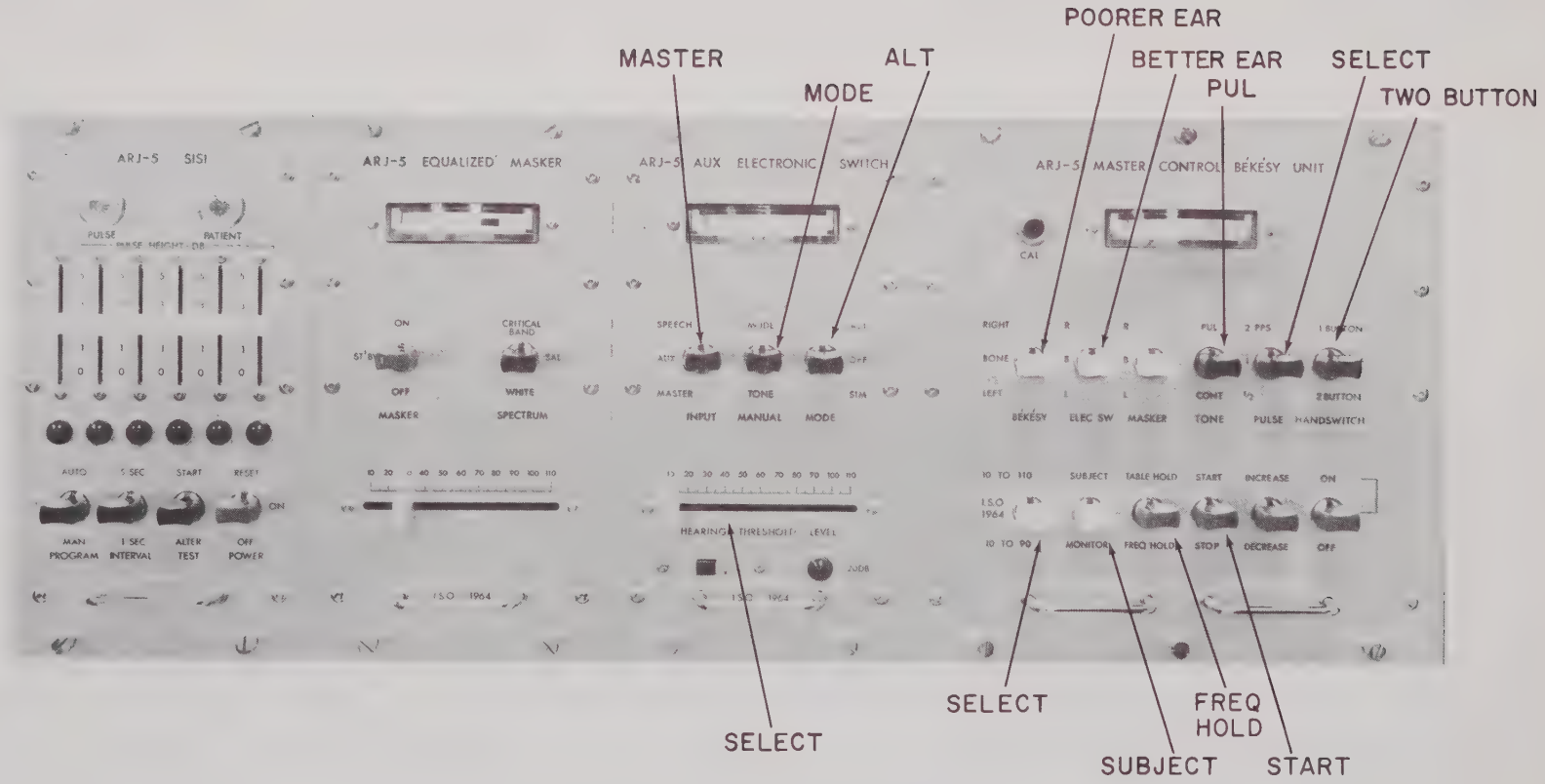


Figure 18. Subject Controlled ABLB

B6-106-130 C

Section 18

1. Set up as shown:
   A. Set table at desired frequency position.
   B. Plug two button handswitch into Master Control Békésy 2 —— H.S. (rear panel) input jack.
   C. Continuously monitor test by watching audiogram card. When sweeps become small and subject has matched tones, increase the presentation intensity level to the good ear (via the Auxiliary Electronic Switch unit) by 20 dB, and let the subject match this level. Continue this process until the limits of the audiometer have been reached in the good ear.

2. Clinical Procedure:

A. ABLB using two-button handswitch.

1. Select the frequency to be tested and set the TABLE HOLD/FREQ HOLD to FREQ HOLD.
2. Instruct the subject to adjust the intensity of the tone to his poorer ear until it is equal in loudness to the tone in his better ear. (Press LOUDER button when tone is too soft; Press SOFTER button when it is too loud. Release both buttons to make judgement.)
3. By use of the Auxiliary Electronic Switch unit, present a tone to the subject's better ear 20 dB above threshold.
4. Present the tone to the poorer ear via the Békésy unit at an arbitrary level above the reported threshold for that ear.
5. Note the level when the subject balances the two tones by the lack of change on the audiogram card (less than a 10 dB span in the sweeps).
6. When the subject has balanced the first tone, increase the intensity to the better ear by 20 dB and repeat the matching process.
7. Continue increasing the intensity to the better ear in 20 dB steps until the maximum intensity level of the audiometer has been reached.
8. Follow the above procedure for each desired frequency, inserting a new audiogram card for each frequency tested.
9. To record the results, note the line which corresponds to the balanced condition and record to the nearest 5 dB. This is the intensity level required by the poorer ear to seem equal in loudness to the tone in the better ear.
10. Plot a laddergram using these results as shown in Interpretation below.

B. Clinical Procedure using one-button handswitch.

1. Plug one-button handswitch into Master Control Békésy 1-H.S. (rear panel) input jack.
2. Select 1 BUTTON on HANDSWITCH control.
3. Select the frequency to be tested and place the TABLE HOLD/FREQ HOLD on FREQ HOLD.
4. Instruct the subject to adjust the intensity of the tone to his poorer ear so that the loudness of the tone in the poorer ear brackets the loudness of the tone in the better ear, i.e., make the tone alternately louder and softer in the poorer ear using the tone in the better ear as the reference. (Press button when tone is too loud; release when it is too soft).
5. By use of the Auxiliary Electronic Switch Unit, present a tone to the subject's better ear 20 dB above threshold.
6. Push START/STOP control to START.
7. Note the level when the subject balances the two tones by the even sweeps on the audiogram card (less than a 10 dB span in the sweeps). See figure A.
8. Follow steps A-6 through A-10 above.

C. Manual Alternate Binaural Loudness Balancing.

1. Place HANDSWITCH control in the center (OFF) position.
2. Select the better ear via the Békésy output and the poorer ear via the ELEC SW output.
3. Select the frequency to be tested and set the TABLE HOLD/FREQ HOLD to FREQ HOLD.

4. Instruct subject to inform you about the intensity of the tone presented to his poorer ear —— is it softer or louder than the tone being presented to the better ear? Explain that you want him to try to balance the loudness of the two tones until they seem equally loud in each ear.
5. Push the INCREASE switch until an intensity level 20 dB above the threshold of the better ear for the selected frequency is reached.
6. Control the intensity presented to the poorer ear by the Hearing Threshold Level ATTENUATOR on the Auxiliary Electronic Switch unit. Alternate the intensity, asking for frequent reports from the subject until he indicates that the two tones seem equal in loudness. Note the intensity level required on the Auxiliary Electronic Switch attenuator.
7. When the subject has balanced the two tones, increase the intensity to the better ear by 20 dB via the INCREASE/DECREASE switch, and repeat the balancing process.
8. Continue increasing the intensity to the better ear in 20 dB steps until the maximum intensity level of the audiometer has been reached, or until tolerance becomes a problem.
9. Follow the above procedure for each desired frequency.
10. Plot a laddergram for each frequency using the obtained results.
11. This test may also be performed by varying the intensity to the better ear and using the poorer ear as the reference ear.

3. Interpretation

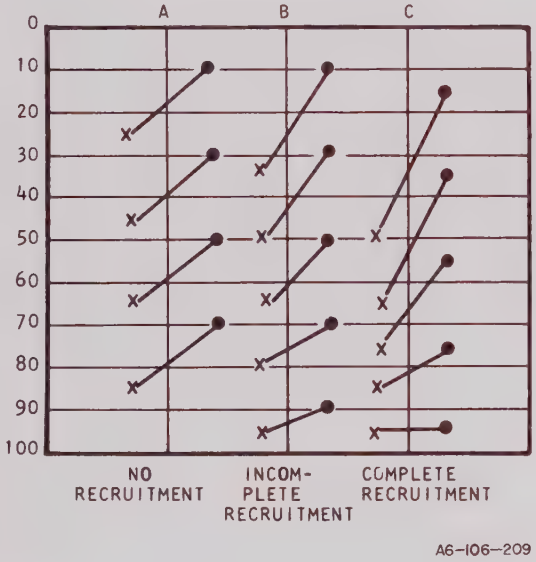
The figure below illustrates possible results for a particular frequency. The points for the good ear (in this case, Right) appear at intervals 20 dB apart,

starting at threshold; the points for the poor ear are marked at the sensation level that was required to balance loudness.

A. No recruitment - lines are parallel.

B. Incomplete recruitment - sensation of loudness in poor ear never equals sensation of loudness in good ear.

C. Complete recruitment - loudness of tone in poor ear equals the loudness in good ear at high intensity levels.



UPPERMOST O AT EACH FREQUENCY = THRESHOLD, RIGHT EAR; UPPERMOST X AT EACH FREQUENCY = THRESHOLD, LEFT EAR.

Reviewers' Comments:

None

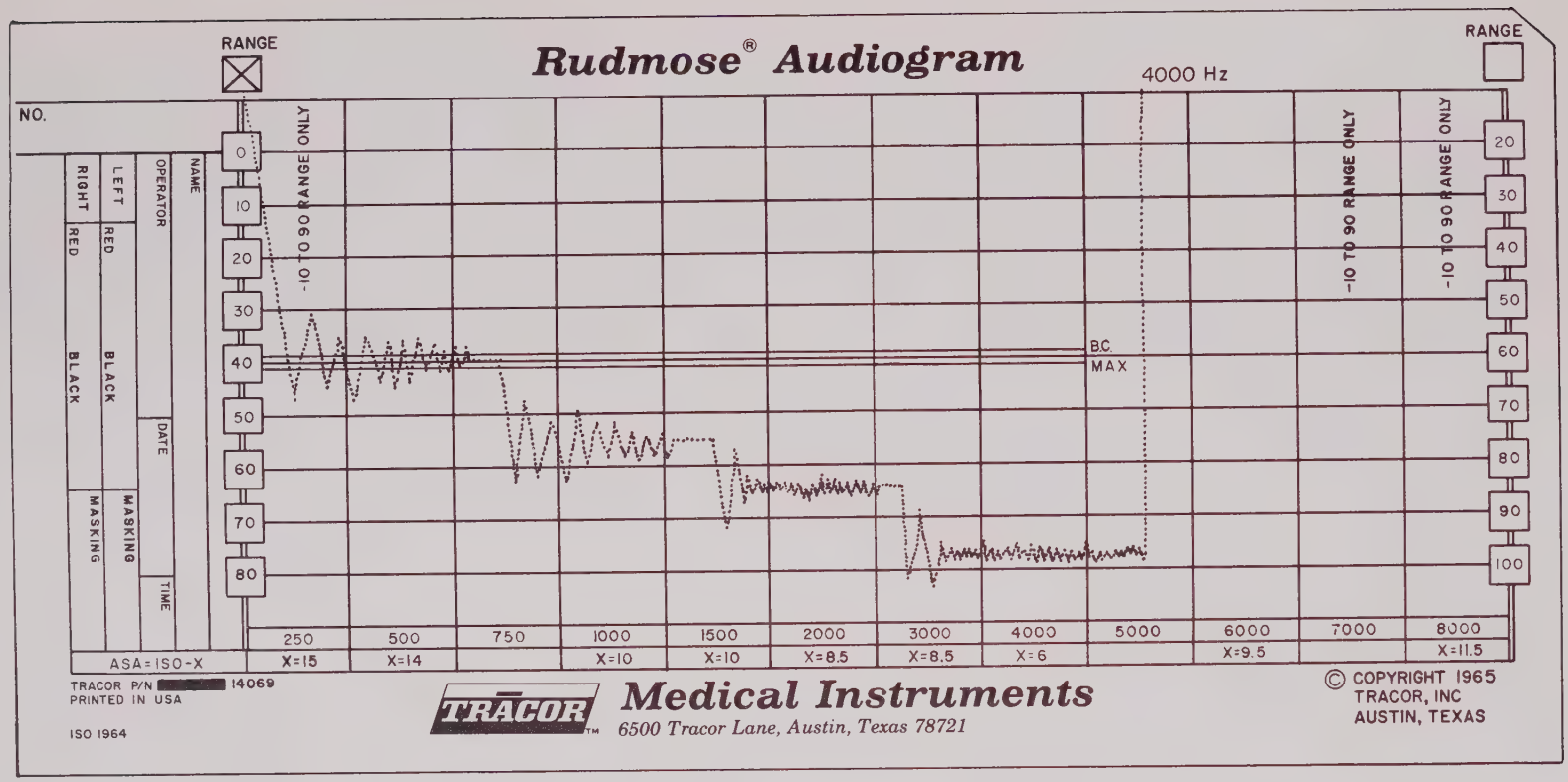


Figure A

Intensities required to balance tones presented to the better ear (via Auxiliary Electronic Switch) at 25 dB, 45 dB, 65 dB, and 85 dB at a fixed frequency (4000 Hz) using one-button handswitch.

SHORT INCREMENT SENSITIVITY INDEX
(SISI Test)

Section 19

Sensorineural loss

References:

Glorig - pp. 142
Newby, 2nd. - pp. 170-174
Sataloff - pp. 325

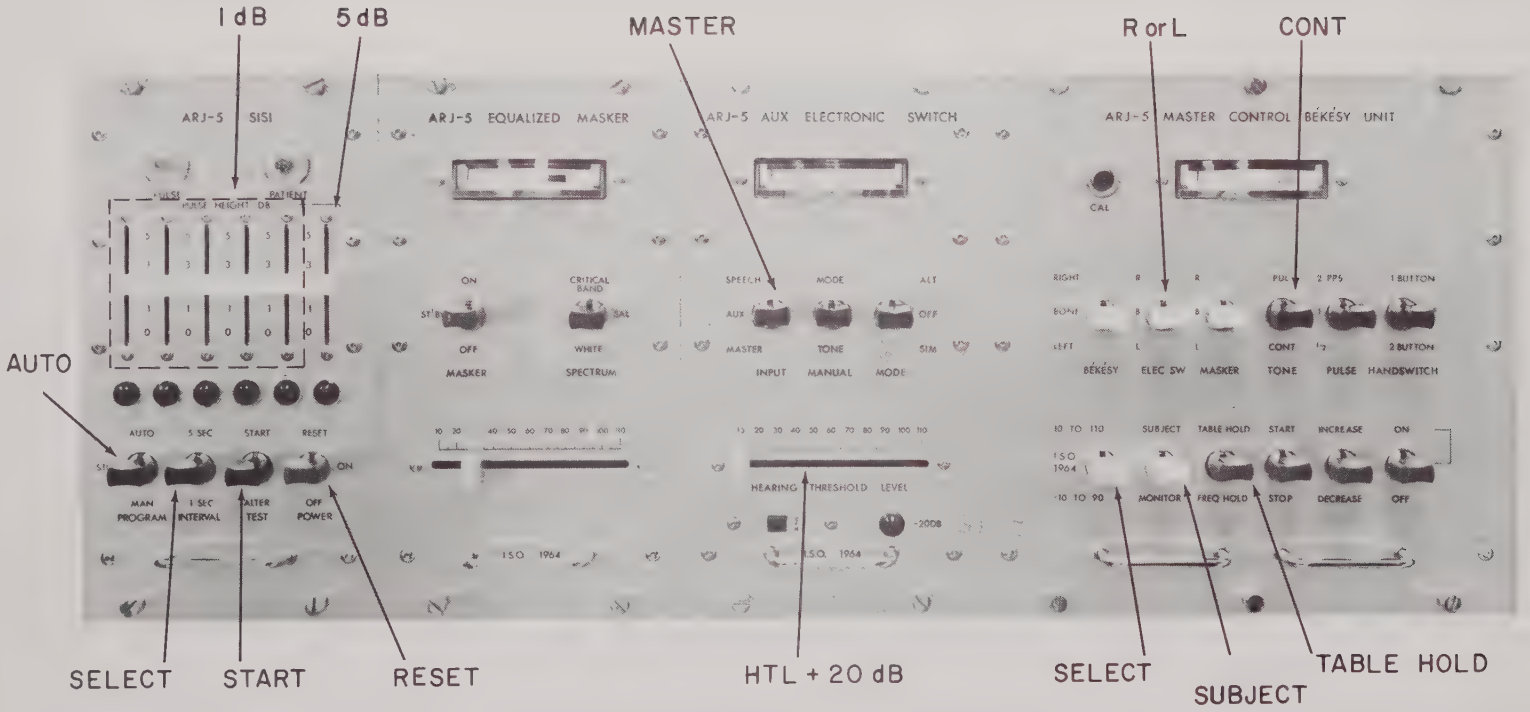


Figure 19. SISI

B6-106-118 A

SHORT INCREMENT SENSITIVITY INDEX
(SISI TEST)

Section 19

1. Set up as shown:
   A. Plug one button handswitch into socket on rear panel of SISI module.
   B. Set table to desired frequency.
   C. Set Auxiliary Electronic Switch Hearing Threshold Level attenuator at 20 dB above subject's threshold for the frequency being presented.

2. Clinical Procedure:

A. Inform the subject that he will hear a constant level tone; during the time it is on he may occasionally hear some little jumps in loudness; some will be loud, some very small. Instruct the subject to press the handswitch each time he detects one of the jumps in loudness.

B. Set the Auxiliary Electronic Switch HEARING THRESHOLD LEVEL attenuator 20 dB above the threshold of the ear under test.

C. A complete test run involves the presentation of 24 increments, with only 20 increments being scored. In order to familiarize the subject with the task, five non-test increments are given as a practice session. Begin with two increments at 5 dB, two at 3 dB, and one at 2 dB. Reset POWER switch and begin the test proper with the 1 dB increments.

D. Four extra increments are added to the twenty as check increments during the test. These check increments follow the fifth, tenth, fifteenth and twentieth 1 dB increments, and their intensity is chosen according to the following rules:

1. If the subject responds to two or less of the first five 1 dB increments, set the sixth increment to 5 dB.

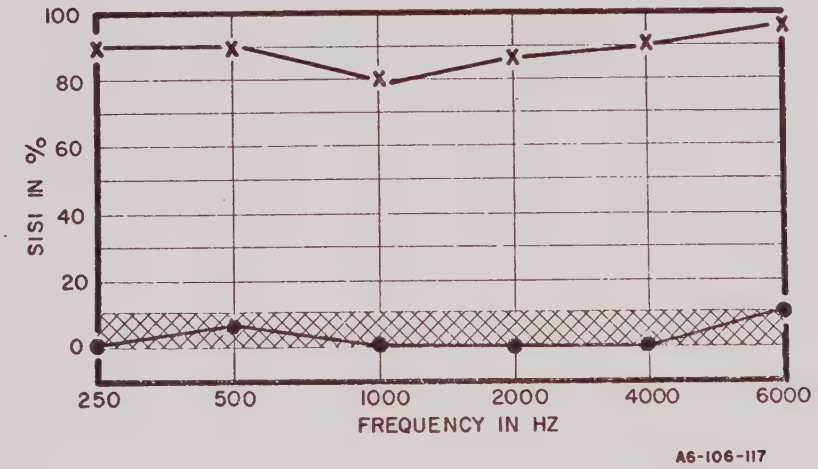
2. If the subject responds to three or more of the 1 dB increments, set the sixth increment to 0 dB.

E. Follow the above procedure for each desired frequency for each ear.

F. Score only the responses to the 1 dB increments.

3. Interpretation:

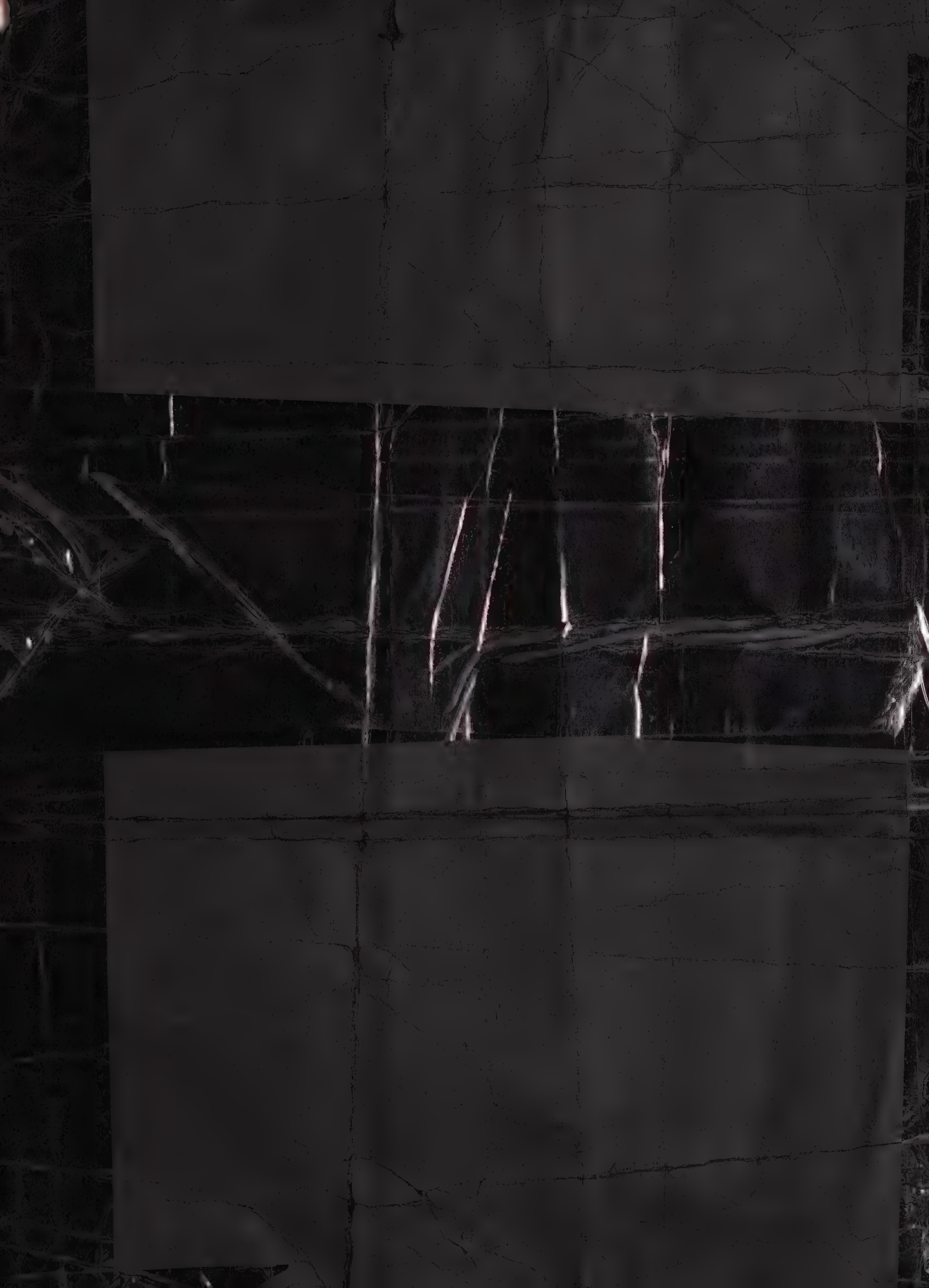
Results should be expressed in terms of the percentage of 1 dB increments to which a correct response is made, 5% for each 1 dB increment detected. Thus if a subject hears ten of the twenty 1 dB increments, he would receive a SISI score of 50%. A SISI-gram may be charted by plotting the SISI score in percent against frequency, using the conventional symbols of 0 and X for right and left ears. The shaded area between 0 and 10% on the sample SISI-gram represents the approximate range of scores to be expected in normal ears, or ears with other than cochlear lesions.



In general, conductive losses yield very low scores (0-15%), while losses presumed to be localized in the cochlear structure of the inner ear tend to show very high scores (70-100%). In the sample SISI-gram above, the subject would have normal hearing, a retrocochlear loss, or a conductive loss in the right ear, and cochlear involvement in the left ear. In presbycusis, any level of performance may be expected; that is, scores may range from 0-100%. At frequencies above 1000 Hz, a 60% (or above) score indicates a cochlear disorder. A lower score with a threshold loss may indicate VIII nerve disorder or middle-ear lesion.

Reviewers' Comments:

None



BÉKÉSY TEST

Section 20

Test to indicate site of lesion

References:

Jerger (1960) - pp. 275-287
Jerger (1963) - pp. 111
Jerger, Carhart and Lassman - pp. 617-623
Jerger and Herer - pp. 390-391
Lierle and Reger - pp. 263-277
Newby - pp. 175-179
O'Neill and Oyer - pp. 144-149, 163-133, 206-207, 307-309
Resnick and Burke - pp. 39-41
Stein - pp. 339-348

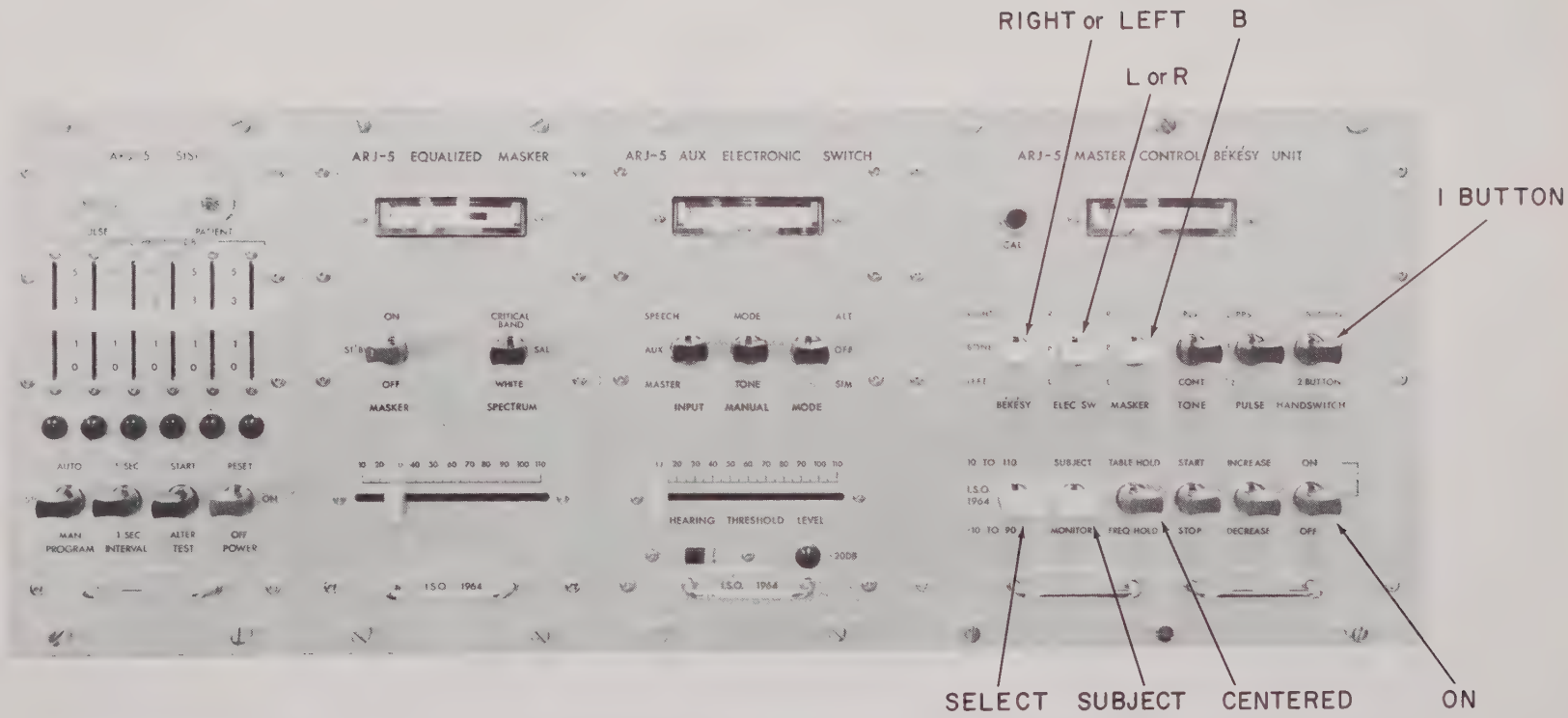
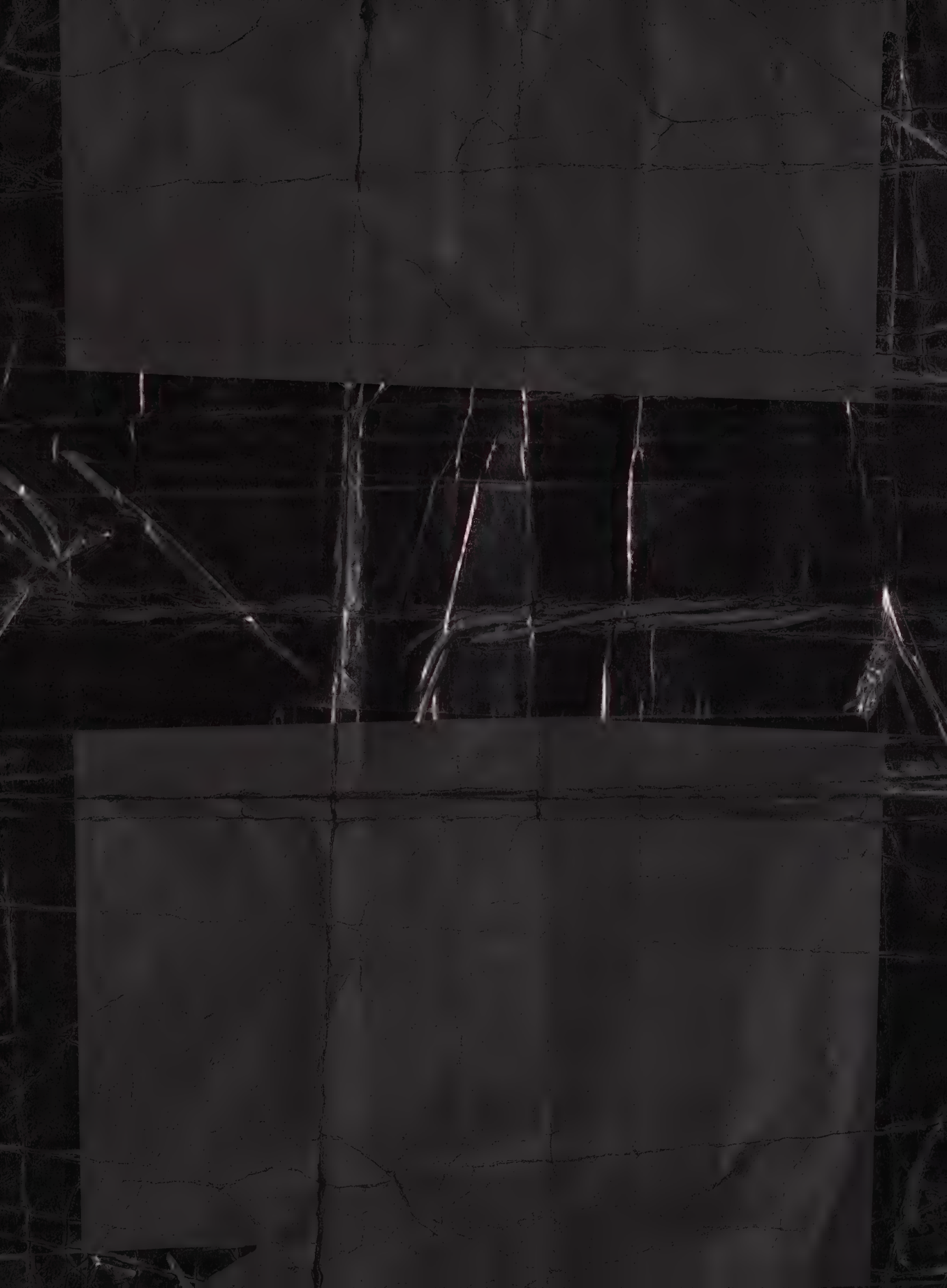


Figure 20. Békésy Test

BÉKÉSY TEST

Section 20

1. Set up as shown:
   A. Plug one-button handswitch into Master Control Békésy 1 —— H.S. (rear panel) input jack.



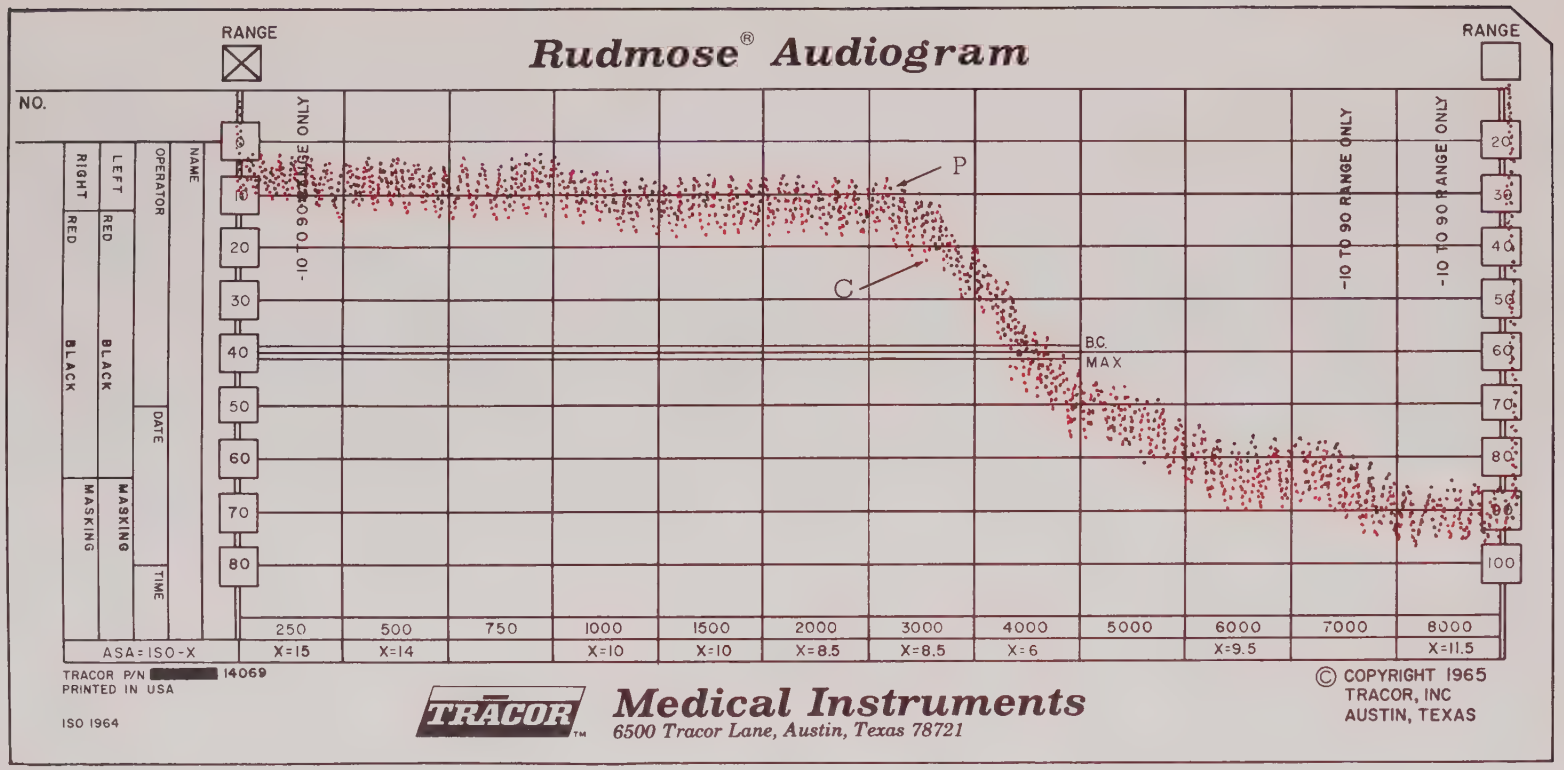
2. Clinical Procedure:
   A. Follow procedure for pure tone air conduction test, selecting pulsed tone and setting RIBBON COLOR LEVER to black.
   B. Select ear to be tested with BÉKÉSY switch.
   C. Administer the test using a pulsed tone.
   D. Return the table all the way to the rear.
   E. Change the ribbon color to red.
   F. Change the TONE switch to CONT.
   G. Begin second test by pressing the START/STOP switch to START.
   H. If anything other than Type I occurs, tests of longer duration over just a few frequencies should be performed. In this case, position the audiogram table for the desired frequency by using the Table Release Knob and depress the TABLE/FREQ HOLD switch to FREQ HOLD. Return table all the way to the rear.

3. Interpretation:
   The following figures illustrate Békésy tracings for Types I through V.
   A. In the Type I tracing (figure A), the continuous tone tracing and the pulsed tone tracing are superimposed at all frequencies for both conventional and fixed-frequency tests. The Type I tracing indicates normal hearing or a conductive hearing loss.
   B. In the Type II tracing (figure B), the continuous and pulsed tone tracings are superimposed for the low frequencies. Beyond 1000 Hz the continuous tone tracing drops 10-15 dB below the interrupted tone tracing (indicating a higher threshold), but remains parallel to it. The Type II tracing indicates a cochlear involvement. However, not all cochlear involvements show Type II tracings.

C. In the Type III tracing (figure C), the continuous tone tracing drops rapidly to the maximum intensity limit of the audiometer. The sharp dropping of the continuous tone tracing can occur at any frequency and indicates retrocochlear involvement. Not all eighth nerve disorders produce Type III tracings.

D. The Type IV tracing (figure D) shows the continuous tone tracing running below the pulsed tone tracing at all frequencies with no overlapping. Although there is seldom a large drop in the continuous tone tracing, it often runs as much as 20 dB below the pulsed tone tracing. The Type IV audiogram differs from the Type II in that there is no overlapping of tracings in the low frequencies and the difference between the continuous and pulsed tone tracings is greater. It is distinguishable from the Type III tracing because the distance between the continuous and pulsed tone tracings does not increase over time. The Type IV tracing indicates a retrocochlear involvement of unknown etiology. Not all retrocochlear involvements show Type IV tracings.

E. In the Type V tracing (figure E), the pulsed tone tracing falls below the continuous tone tracing, indicating a lower (better) threshold for the continuous stimulus. Since the pulsed tone tracing is ordinarily equal to or better than the continuous tone tracing (there is more chance of adaptation with a continuous tone), the Type V tracing often indicates functional hearing loss. Although further research needs to be performed, the Type V Békésy tracing presents interesting possibilities in identification of functional hearing loss.



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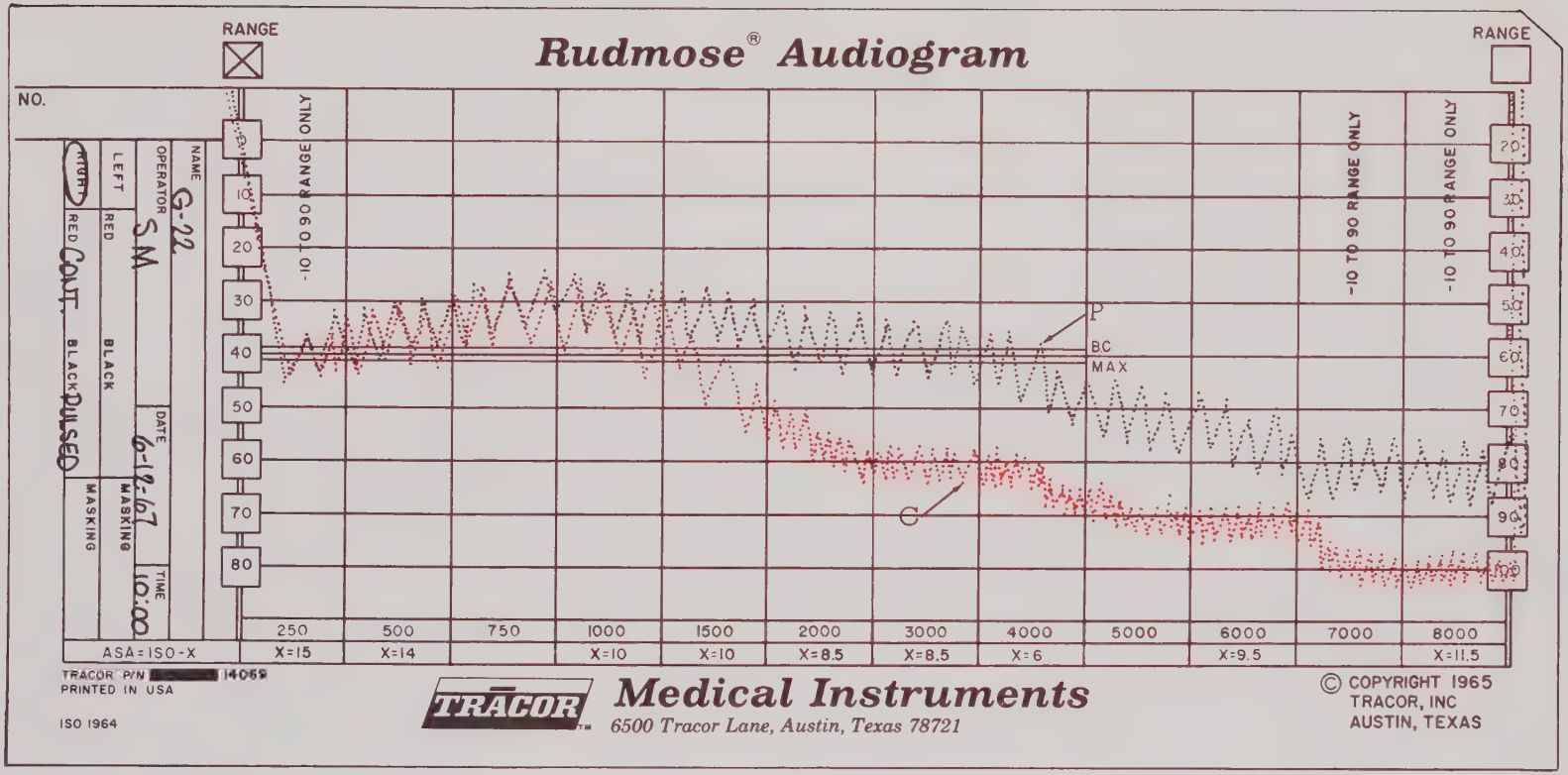
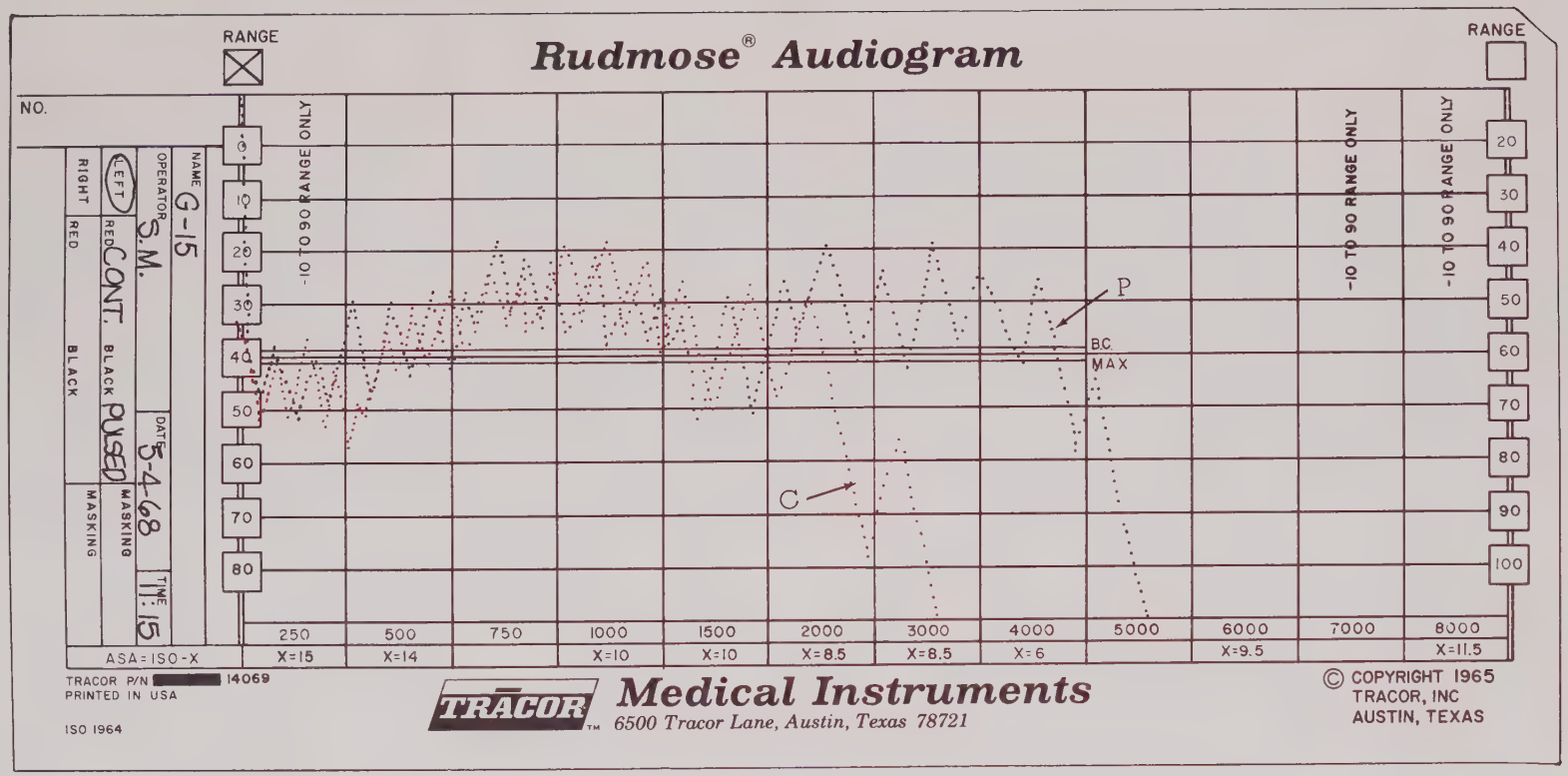
Type I

Figure A



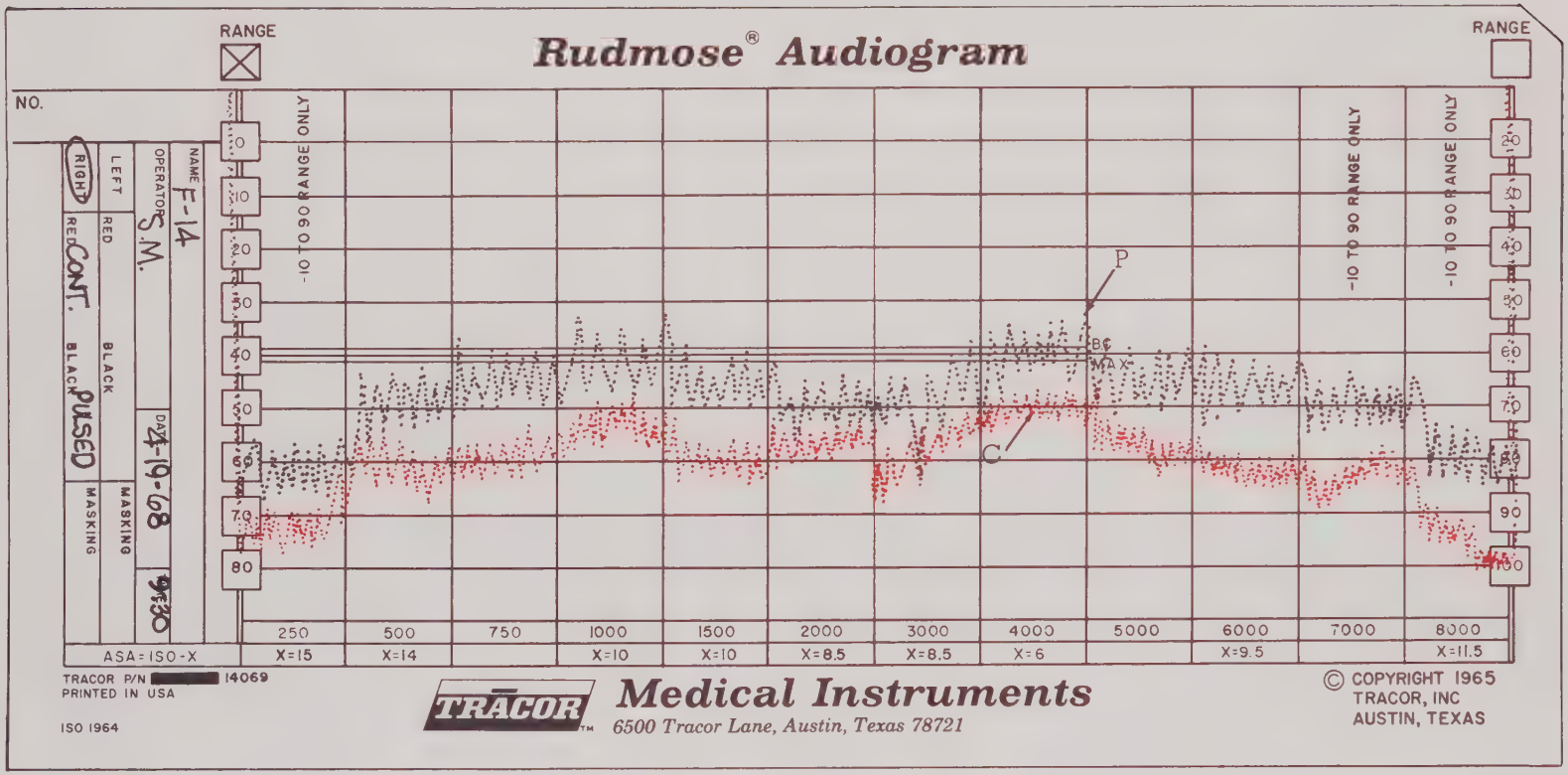
Type II

Figure B



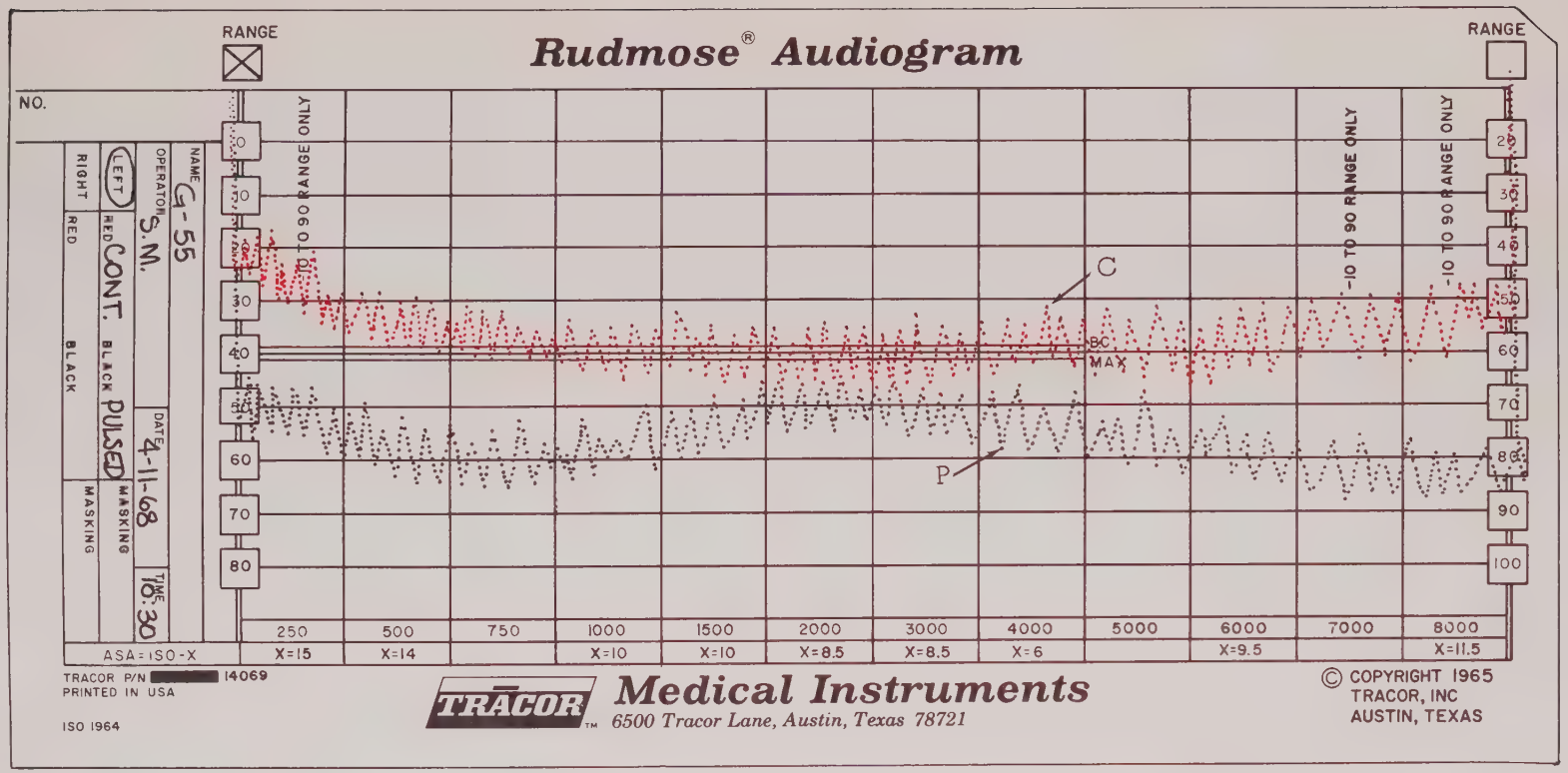
Type III

Figure C



Type IV

Figure D

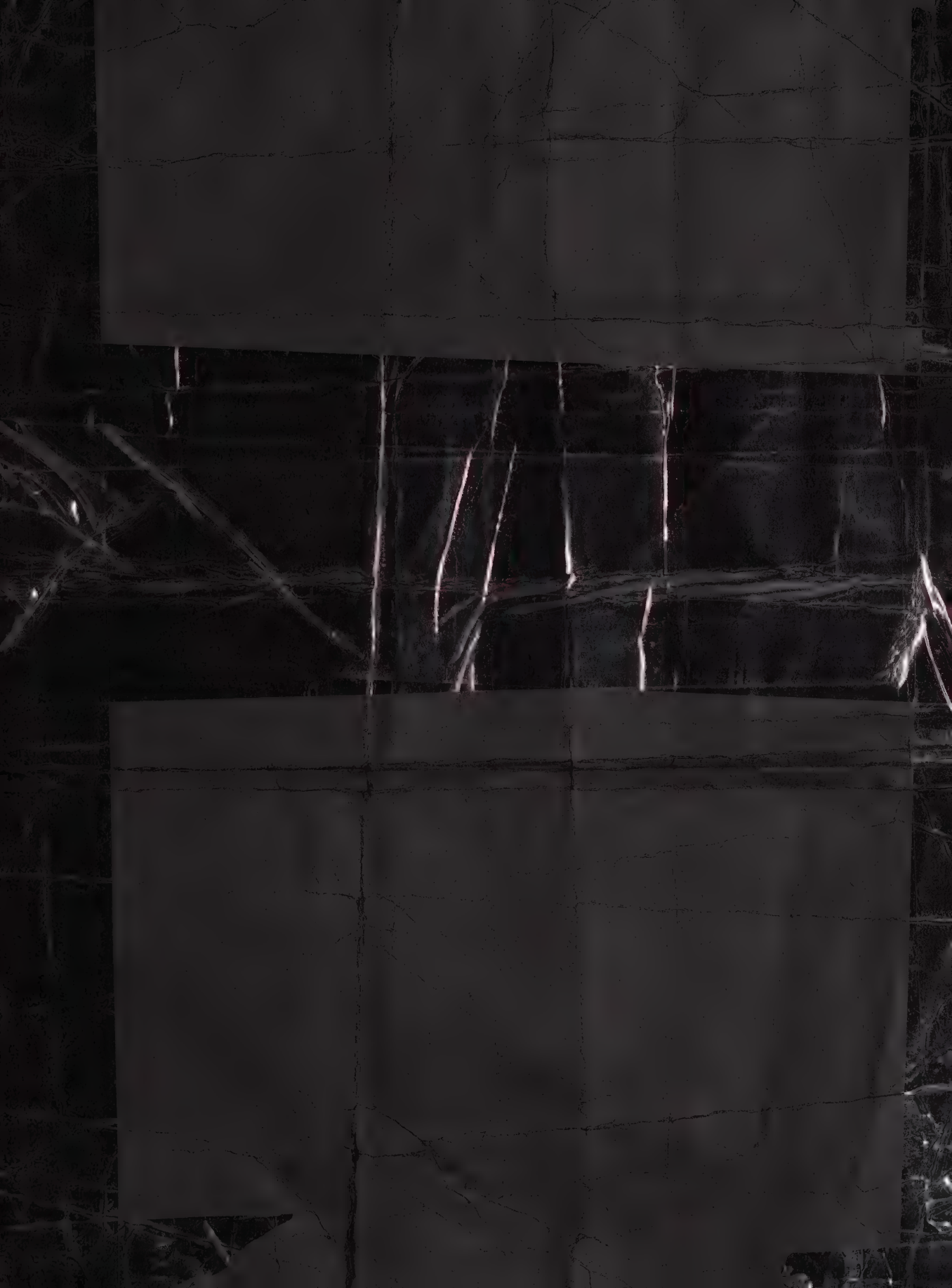


Type V

Figure E

Reviewers' Comments:

None



MODIFIED TONE DECAY TEST

Section 21

Determination of site of lesion

References:

Glorig - pp. 142-144

Green, D.S. "The Modified Tone Decay Test (MTDT) as a Screening Procedure for Eighth Nerve Lesions", JSHD, 28:31, 1963.

Hirsh - pp. 177-187

Portmann & Portmann - pp. 58-60

Sataloff - pp. 333-334

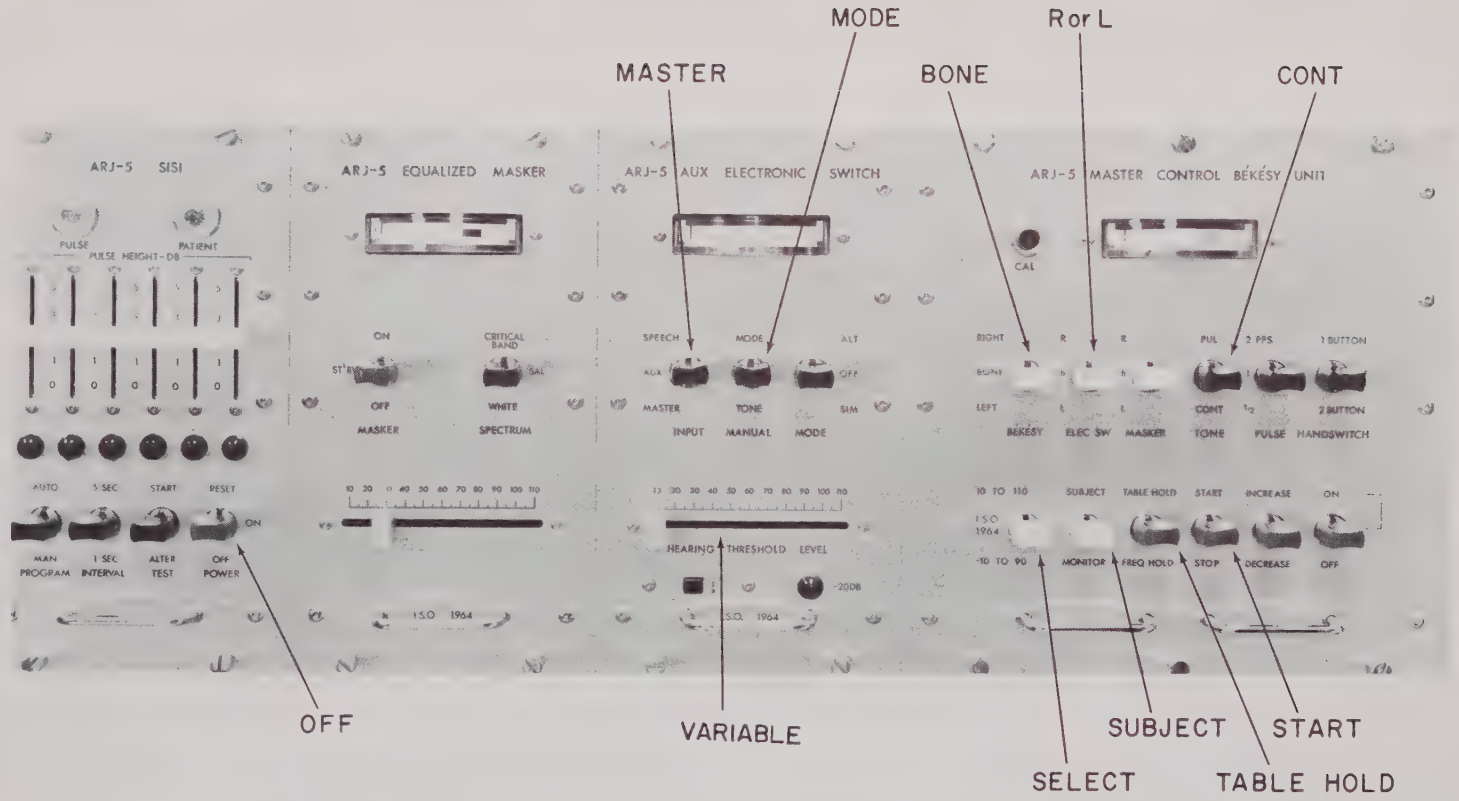


Figure 21. Modified Tone Decay Test

B6-106-133A

MODIFIED TONE DECAY TEST

Section 21

1. Set up as shown:
   A. Select desired frequency.

2. Clinical Procedure:

   A. Select a frequency which shows reduced threshold and instruct the subject to raise his finger as long as he hears the tone.

   B. Select a continuous tone, and present it 5 dB above threshold. Use a stop watch to time each presentation.

   C. Each time the subject lowers his finger, immediately increase the intensity by 5 dB without interrupting the tone, and note the time for that period of hearing.

   D. Continue this procedure for one minute, noting the time of hearing for each intensity level.

3. Interpretation:

   A person without abnormal tone decay will usually hold up his finger for the entire 60 seconds. Occasionally a subject may require a 5 or 10 dB increase during the first part of the test, but then he will maintain the tone for the remainder of the time. A subject who has abnormal tone decay may lower his finger after only 10 or 15 seconds, and continue to indicate that the tone fades out rapidly at each higher level. Abnormal tone decay is indicative of a retrocochlear involvement.

Reviewers' Comments:

None

REFERENCES

1. Carhart, R., "Clinical Determination of Abnormal Auditory Adaptation", Archives of Otolaryn, vol. 65 (1957) 32.

2. Davis, H. and Silverman, S. R., Hearing and Deafness, New York: Holt, Rinehart and Winston, Inc., 1962.

3. Denes, P. and Naunton, R. F., "The Clinical Detection of Auditory Recruitment", Journal of Laryngology and Otology, vol. 64 (July 1950) 375-398.

4. Glorig, A., Audiometry: Principles and Practices, Baltimore: The Williams and Wilkins Company, 1965.

5. Green, D. S., "The Modified Tone Decay Test (MTDT) as a Screening Procedure for Eighth Nerve Lesions", JSHD, 28 (1963) 31.

6. Hirsh, I. J., The Measurement of Hearing, New York: McGraw-Hill Book Company, Inc., 1952.

7. Jerger, J. F., "A Difference Limen Recruitment Test and its Diagnostic Significance", Laryngoscope, vol. 62 (December 1952) 1316-1322.

8. Jerger, J. F., "D L Difference Test: Improved Method for Clinical Measurement of Recruitment", A.M.A. Archives of Otolaryngology, vol. 57 (May 1953) 490-500.

9. Jerger, J. F., "Recruitment and Allied Phenomena in Differential Diagnosis", Journal of Auditory Research, vol. 2 (1961) 151.

10. Jerger, J. F., Mier, M., Boshes, B., and Canter, G., "Auditory Behavior in Parkinsonism", Acta Oto-Laryngologica, vol. 52 (December 1960) 541-550.

11. Jerger, J. F., and Tillman, T., "A New Method for the Clinical Determination of Sensorineural Acuity Level (S.A.L.)", Arch. Otolaryng., 71 (1960) 948.

12. Jerger, J. F., "Bekesy Audiometry in Analysis of Auditory Disorders", Journal of Speech and Hearing Research, vol. 3 (Sept. 1960)275-287.

13. Jerger, J. F., Modern Developments in Audiology, New York: Academic Press, 1963.

14. Jerger, J. F., Carhart, Raymond and Lassman, Joyce, "Clinical Observations on Excessive Threshold Adaptation", A.M.A. Archives of Otolaryngology, vol. 68 (Nov. 1958) 617-623.

15. Jerger, J. F. and Herer, G., "Unexpected Dividends in Békésy Audiometry", Journal of Speech and Hearing Disorders, vol. 26 (1961) 390-391.

16. Langenbeck, B., Textbook of Practical Audiometry, Baltimore: The Williams and Wilkins Company, 1965.

17. Lierle, D. M. and Reger, Scott, "Experimentally Induced Temporary Threshold Shifts in Ears with Impaired Hearing", Annals of Otology, Rhinology and Laryngology, vol. 64 (March 1955) 263-277.

18. Newby, H. A., Audiology, Principles and Practice, New York: Appleton-Century-Crofts, 1958.

19. Newby, H. A., Audiology, Second Edition, New York: Appleton-Century-Crofts,1964.

20. O'Neill, J. J. and Oyer, H. J., Applied Audiometry, New York: Dodd, Mead & Company, Inc., 1966.

21. Portmann, M. and Portmann, C., Clinical Audiometry, Springfield: Charles C. Thomas, 1961.

22. Rainville, M. J., New Method of Masking for the Determination of Bone Conduction Curves, Translations of the Beltone Institute for Hearing Research (Nov.11,1959).

23. Resnick, D. M. and Burke, K. S., "Békésy Audiometry in Nonorganic Auditory Problems", Archives of Otolaryngology, vol. 76 (1962)39-41.

24. Sataloff, J., Hearing Loss, Philadelphia: J. B. Lippincott Company, 1966.

25. Simon, G. R. "The Sensorineural Acuity Level (SAL) Technique with Narrow-Band Noise", Journ. Aud. Res., 4 (1964) 191-194.

26. Stein, L., "Some Observations on Type V Békésy Tracings", Journal of Speech and Hearing Research, vol. 6 (1963) 339-348.

27. Zwislocki, J.J., "Acoustical Attenuation Between the Ears", JASA #4, vol. 25 (1953) 752-759.

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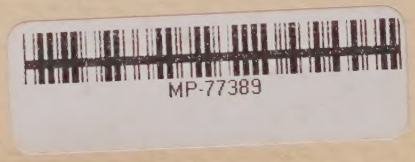
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